Revista Argentina de Ciencias del Comportamiento

ISSN 1852-4206

Abril, 2026, Vol. 18, N°1, 68-75

revistas.unc.edu.ar/index.php/racc

The elevated plus maze for the assessment of activity and anxiety in a wild subterranean rodent: role of illumination and mystacial vibrissae

Schleich, Cristian Eric*, [a]

Original Article

Tabla de Contenido

Abstract

The elevated plus maze (EPM) test is widely used for assessing anxiety-like behavior. A variety of factors and procedural variables can influence behavior in the EPM. In the case of subterranean rodents, which spend most of their lives in constant darkness and are exposed to extensive somatosensory stimuli, both illumination levels and vibrissae removal can exert profound effects on their EPM behavior. Hence, the behavior of a wild subterranean rodent, Ctenomys talarum, was investigated in the EPM under two contrasting illumination levels in combination with removal of mystacial vibrissae. Illumination conditions and vibrissal removal did not affect transparent arm exploration in the EPM. Besides, low illumination intensity caused an increase in the distance traveled by tuco-tucos (C. talarum), although absence of vibrissae caused a clear exploration decrement. Both life-history characteristics and experimental conditions must be taken into account when using the EPM to assess anxiety and other behavioral parameters.

Palabras clave:
elevated plus maze, subterranean rodent, illumination, vibrissae, anxiety

Resumen

El laberinto elevado en cruz y su utilización en la evaluación de la actividad y ansiedad en un roedor subterráneo silvestre: rol de la iluminación y de las vibrisas mistaciales. El laberinto en cruz elevado (LE) se utiliza ampliamente para evaluar el comportamiento de ansiedad. Varios factores pueden influir el comportamiento en el LE. En el caso de los roedores subterráneos, tanto los niveles de iluminación como la eliminación de las vibrisas pueden ejercer efectos profundos en su comportamiento. Se investigó el comportamiento del roedor subterráneo silvestre Ctenomys talarum en el LE bajo dos niveles de iluminación en combinación con la eliminación de las vibrisas mistaciales. Las condiciones de iluminación y la eliminación de las vibrisas no afectaron los parámetros de ansiedad. Además, la baja intensidad de iluminación provocó un aumento de la distancia recorrida por los tuco-tucos (C. talarum), aunque la ausencia de vibrisas provocó una clara disminución de la exploración. Tanto las características de historia de vida como las condiciones experimentales deben tenerse en cuenta al utilizar el LE para evaluar la ansiedad y otros parámetros de comportamiento.

Keywords:
laberinto en cruz elevado, roedor subterráneo, iluminación, vibrisas, ansiedad

Recibido el 25 de octubre de 2023; Aceptado el 13 de mayo de 2025
Editaron este artículo: Paula Giménez, Carolina Caverzan, Daniela Lanchini y María del Pilar Castillo

Several and diverse tests are used to evaluate exploratory activity and anxiety-like behaviors in rodents, the elevated plus maze (EPM) being one of the most common in the measurement of ethological parameters related to anxiety (Walf & Frye, 2007). This test consists in placing an individual in the center of a plus-shaped maze elevated above the floor; two of the arms are enclosed with walls on their edges and the other two arms are open or with transparent ledges. Then, the time spent and distance traveled in each arm is recorded for a certain period of time. Generally, rodents prefer to walk and stay in the protected or enclosed arms instead of exploring the exposed or open transparent arms, being the ratio among open/closed arms an index of anxiety: lesser anxiety levels allow longer and more frequent exploration periods of the open arms (Becerra Garcia et al., 2005).

Despite the fact that this test has been used in

[a] Universidad Nacional de Mar del Plata, Instituto de Investigaciones Marinas y Costeras Laboratorio de Ecofisiología - CONICET, Mar del Plata, Argentina.
*Enviar correspondencia a: Schleich, C. E. E-mail: cschleic@mdp.edu.ar

Citar este artículo como: Schleich, C.E (2026). The elevated plus maze for the assessment of activity and anxiety in a wild subterranean rodent: role of illumination and mystacial vibrissae. *Revista Argentina de Ciencias del Comportamiento, 18*(1), 68-75

a substantial number of physiological, behavioral and pharmacological studies (Carobrez & Bertoglio, 2005), several factors appear to influence the performance of individuals in the EPM. First, the outcomes of the test can be affected by the species, strain, age and sex of the animals being tested (Boguszewski & Zagrodzka, 2002; Carola et al., 2002; Shishelova, 2006). Besides, other factors intrinsically linked to the test procedure, like the apparatus assembly (walls/arms colors, arm width, presence of ledges or walls in open arms) or the prior experience of the individuals (exposition to stress factors, time of testing, repeated test exposures, level of illumination) can also affect the behavior of rodents in the maze (Carobrez & Bertoglio, 2005).

As explained before, EPM tests are traditionally used and validated for rats and mice (Pellow et al., 1985), and there are few studies that have extended the use of EPM to wild species of rodents (Carobrez & Bertoglio, 2005; Manaf et al., 2003; Rico et al., 2019). As a general rule, laboratory behavioral paradigms have been designed for more typical animal models, including aspects suited to their sensorial capabilities (Hite et al., 2022). Therefore, some of the laboratory behavioral paradigms design characteristics may not be translatable to more atypical research models, like subterranean rodents (Hite et al., 2002), whose sensorial world diverges from what surface-dwelling rodents confront. The tuco-tucos (*Ctenomys, Ctenomyidae*) are caviomorph rodents distributed in the southern cone of South America (Reig et al., 1990). *Ctenomys talarum* is a small subterranean rodent that lives solitarily in a system of closed burrows parallel to the soil surface (Busch et al., 2000). This species has been subject to several physiological and behavioral studies (reviewed in Fanjul et al., 2021), including an extensive analysis on its sensorial capabilities. Among them, two sensorial characteristics of subterranean rodents in general, and of tuco-tucos in particular, differentiate *Ctenomys talarum* from surface-dwelling rodents. First, vision in underground habitats is useless and subterranean species carry out most of their daily activities in complete darkness (although this species is sighted); and second, subterranean rodents are exposed to extensive somatosensory stimuli due to continuous contact with burrow walls (Kimchi & Terkel, 2004), with mystacial vibrissae playing an important role in thigmotactic perception.

Previous studies have successfully proved the utility of the EPM to evaluate anxiety levels in tuco-tucos after predatory stress (Brachetta et al., 2015; 2016). However, these studies were carried out under standard conditions used for model species. Therefore, in an attempt to understand how life-history characteristics may influence the behavioral response of organisms in EPM tests, and considering the effect that visual and tactile cues may have on the performance of this species of subterranean on diverse behavioral paradigms, the behavior of *C. talarum* in the EPM was investigated under two contrasting illumination levels, combined with removal of mystacial vibrissae.

Methodology

Animals

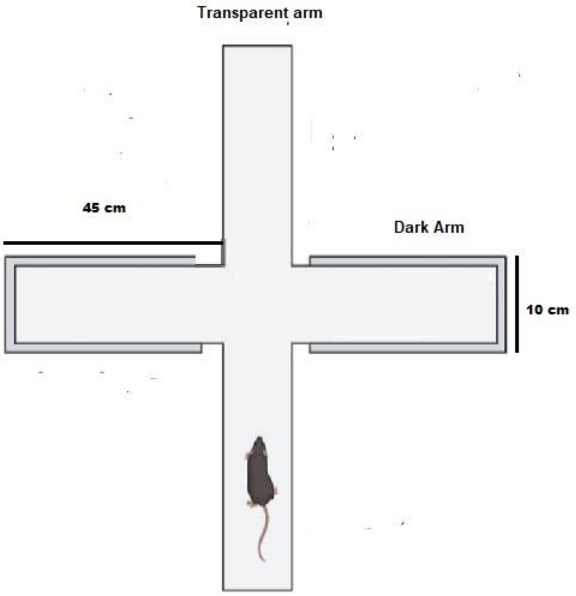
Forty male adults of C. talarum were captured in Villa Gesell (37°15′S 56°58′O, Buenos Aires province, Argentina) using wire mesh live traps (diameter 10 cm) located at burrow entrances. The trapping was done during the day (10 am to 2 pm) and the traps were constantly checked to avoid individuals from being exposed on the surface for extended periods of time. Captured males were then carried to the laboratory and housed individually in non-enriched plastic boxes (30 × 40 × 25 cm), provided with a grill as a lid, half a flowerpot (as a shelter) and wood chips as nesting material, under controlled temperature and photoperiod (25 ± 1 °C; LD 12:12). Food was supplied daily and consisted of sweet potatoes, lettuce, corn, mixed grass and sunflower seeds (see Brachetta et al., 2015). After 7 days of acclimatization to the laboratory, the animals were used in the different experiments.

The capture, handling, and captive maintenance of all animals were performed in accordance with the guidelines approved by the American Society of Mammalogy and the local committee for animal use and care in research (CICUAL, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Mar del Plata, RD 2022-86).

Elevated Plus Maze

The EPM consisted of an acrylic cross with two opposite transparent arms made with ledges and two arms with closed dark walls. The length of the arms was 45 cm and extended from a central platform of 10 cm × 10 cm (Figure 1). The maze was raised 70 cm above floor level with a wooden stand. The animals were taken to the labyrinth and placed in the central platform to begin the experiment. Tuco-tucos' behavior was registered using a video camera for 5 min. The following parameters were determined from the recordings: total number of arm entries, number of entries to transparent arms/dark arms, time of permanence in transparent arms/dark arms (sec), total distance (cm), distance traveled in transparent arms/dark arms. After each experiment, the labyrinth was cleaned with water and odorless detergent.}

Figure 1.
Schematic diagram of the elevated plus-maze test



Procedure

Tuco-tucos were randomly assigned to one of four groups depending on the illumination level (High-250lux- or Low-5lux-) and the presence of vibrissae (with or without):

-Group 1: High illumination with vibrissae.
-Group 2: High illumination without vibrissae.
-Group 3: Low illumination with vibrissae.
-Group 4: Low illumination without vibrissae.

Illumination intensities were previously measured with a luximeter placed in the central square of the EPM. To remove vibrissae in individuals of groups 2 and 4, tuco-tucos were anesthetized 3 hours before testing in a glass chamber with a cotton imbibed with isoflurane (100%). Once anesthesia was achieved, all mystacial vibrissae were removed by clipping with fine scissors. The other groups (1 and 3) were also anaesthetized and their vibrissae touched with the scissors but without cutting.

Statistical analysis

To analyze the effects of illumination and vibrissae, a two-way ANOVA was performed. The following parameters were compared: total number of arm entries, number of entries to transparent arms/dark arms, time of permanence in transparent arms/dark arms (sec), total distance (cm), distance traveled in transparent arms/dark arms. All tests were used with significance set at $p < 0.05$. Normality and equal variance were tested (Shapiro-Wilk and Levene tests, respectively). Time spent in transparent arm/dark arms and total distance traveled were log transformed to comply with test assumptions. Tukey test was performed as post-hoc.

Results

Total number of arm entries

An effect of vibrissae removal was observed on the total number of arm entries, with fewer entries in individuals without vibrissae ($F = 10.23(1)$, $p = 0.003$, Figure 2A). No effect of illumination level ($F = 0.31(1)$, $p = 0.579$) nor interaction of both factors was observed on the total number of arm entries ($F = 0.001(1)$, $p = 0.97$).

Number of entries between transparent/dark arms

No effect of illumination level or vibrissae removal was observed on the number of entries between transparent/dark arms ($F = 0.02(1)$, $p = 0.87$; $F = 0.01(1)$, $p = 0.91$, for illumination and vibrissae, respectively, Figure 2B).

Time spent in transparent /dark arms

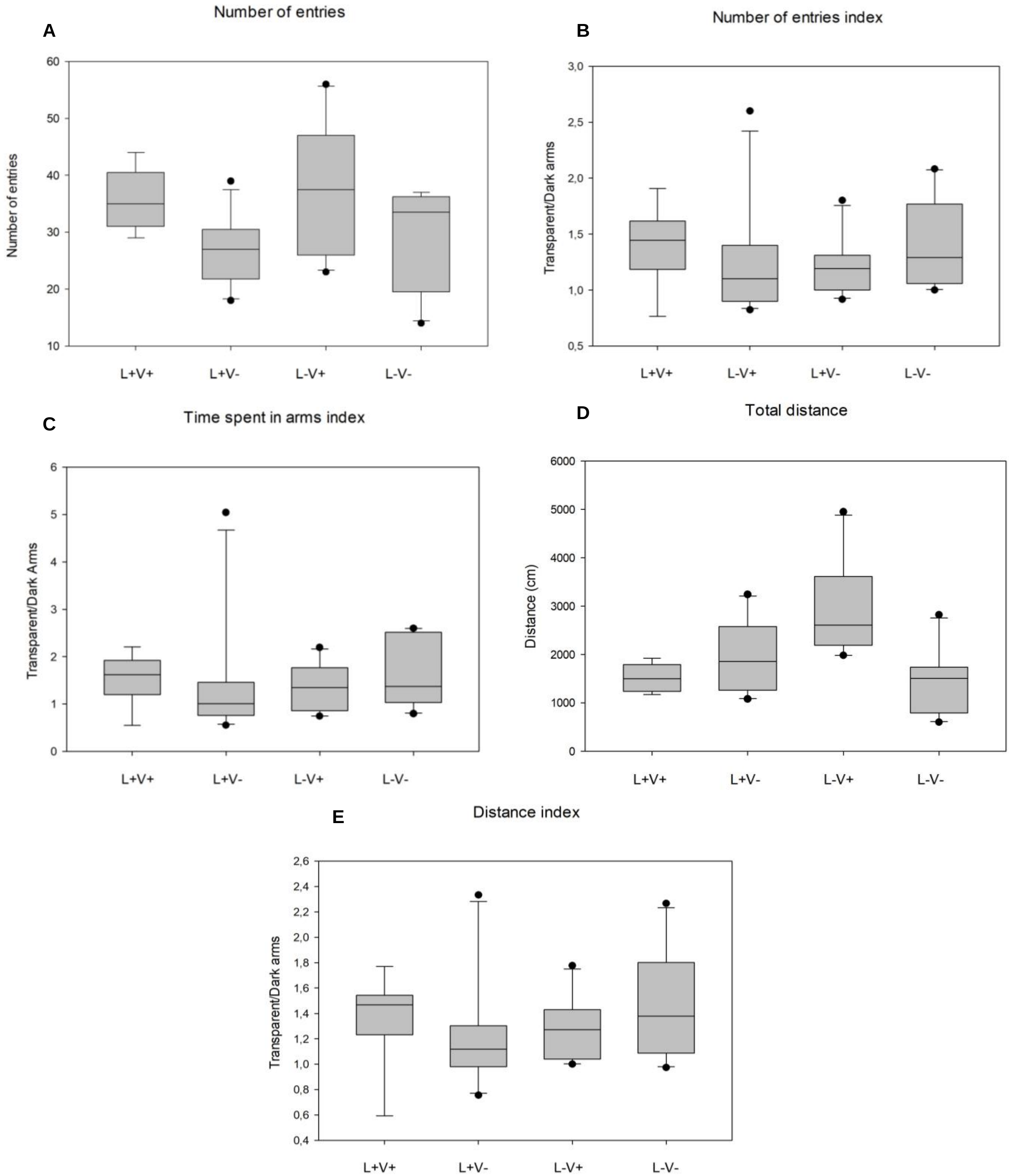
No effect of illumination level or vibrissae removal was observed on the time spent in transparent/dark arms ($F = 0.00(1)$, $p = 0.98$; $F = 0.14(1)$, $p = 0.70$, for illumination and vibrissae, respectively, Figure 2C).

Total distance traveled

No effect of illumination level was observed on the total distance traveled ($F = 1.5(1)$, $p = 0.22$). An effect of vibrissae removal was observed on the total distance traveled in the arms, with individuals without vibrissae moving less than intact animals ($F = 4.76(1)$, $p = 0.03$). An interaction between both factors was observed ($F = 17.3(1)$, $p \le 0.001$), with individuals with

Figure 2.

Boxplots representing median, quartiles and max-min values of (A) number of entries, (B) number of entries to transparent/dark arms (index), (C) time spent in transparent/dark arms, (D) total distance traveled (cm) and (E) distance traveled in the transparent/dark arms (index) by individuals of Ctenomys talarum in the EPM.



Note. L = light, V = vibrissae, + = present, - = absent. The lines indicate statistically significant effects of vibrissal removal.

vibrissae under dark conditions exploring more than others under the rest of conditions ($p < 0.05$, Figure 2D).

Distance traveled in transparent arm/dark arms

No effect of illumination level or vibrissae removal was observed on the distance traveled in transparent/dark arms ($F = 0.13_{(1)}$, $p = 0.71$; $F = 0.24_{(1)}$, $p = 0.62$, for illumination and vibrissae, respectively, Figure 2E).

Discussion

The extended use of the EPM for other species of rodents initiated a series of studies orientated to the understanding of how variation in testing conditions may or may not influence the performance of the individuals in this behavioral test. First, the individuals' intrinsic characteristics (species, strain, sex and/or age) seem to modify rodents' behavior in the maze. For example, old Wistar rats explored the EPM less and were less active in comparison to younger ones (Morato Andrade et al., 2003). In a series of behavioral paradigms that included the EPM, various mouse strains displayed divergent performances, including variations due to mouse gender (Võikar et al., 2001). Moreover, some rodents differed in their behavior in the EPM in relation to the time of the day and the circadian cycle. For instance, male Wistar rats decreased open arm exploration when tested during the nocturnal phase in comparison to the diurnal phase (Carobrez & Bertoglio, 2005).

Besides the individuals' characteristics, various testing factors seem to affect the outcomes of the EPM. Among them, the illumination level seems to be one of the most significant variables affecting arms exploration. In Wistar rats, for instance, open arm exploration and risk assessment decreased under high illumination in both circadian phases, although general locomotor activity only decreased during the nocturnal phase (Carobrez & Bertoglio, 2005). In males of the same variant, exploratory behavior in open arms was more frequent under low illumination intensities (0 and 1 lx) than under high levels of illumination/light (3 to 300 lx), although locomotor behavior (frequency of entries and distance run) was not altered under any illumination condition (Becerra Garcia et al., 2005). However, a few studies also indicate that illumination may not affect rodents' behavior on the EPM. For example, male Wistar rats Shoe: Wist (Shoe) tested under three different illumination levels did not affect individuals' performance at the EPM (Becker & Grechsch, 1996). Additionally, the exploration of open arms under dark conditions did not vary in male Sprague–Dawley rats, although they did display an increased locomotor activity (Jones & King, 2001).

Besides illumination levels, various studies indicated that vibrissal tactile perception affects diverse behaviors in several species of rodents. For example, whisker removal affected defensive behavior in rats (Shishelova, 2006) and platform location in the Morris water maze (Grigoryan et al., 2005). However, results for the EPM are more variable. For example, Belzung (1999) showed that mice without vibrissae displayed a similar behavior in both the closed and the open arms of the EPM. A second example is Filgueiras et al. (2014), who analyzed the behavior of male Wistar rats after cutting their vibrissae and found no differences with those with intact vibrissae. Also, some authors related the effects of vibrissae removal with illumination intensity, with rats using visual cues to discriminate open and closed arms, but shifting to vibrissal information when illumination levels are low (Martínez et al., 2002).

In comparison to species commonly used to assess anxiety behaviors in the EPM, subterranean rodents display remarkable variations in their life-history characteristics that may influence their performance at anxiety tests. One characteristic is the visual capability of this particular group of mammals. The darkness of the underground ecotope makes vision useless in the tunnels, diminishing selection pressure acting on the visual system and leading to regressions in various visual structures in several subterranean species (Kott et al., 2010). This considerable difference in the visual environment of subterranean rodents could suggest the existence of wide variations in anxiety levels when evaluated in contrasting illumination conditions, particularly at high levels (Kapogiannatou et al. 2016), when bright illumination can cause great anxiogenic effects in a species habituated to dark environments. Interestingly, in the present study, illumination intensity (at the tested levels) did not affect transparent arm exploration, the most reliable anxiety index in the EPM. Nevertheless, low levels of illumination caused an increment in the distance traveled (with vibrissae), indicating that exploratory activity may be affected by illumination levels in *Ctenomys talarum*.

As explained before, subterranean rodents are in constant contact with tunnel walls, receiving more tactile information than surface-dwelling rodents (Kimchi & Terkel, 2004). This situation is associated with a higher utilization of tactile stimuli while exploring and learning a complex maze in blind mole rats (Kimchi & Terkel, 2004) and with an expanded somatosensory cortex, notoriously larger compared to the laboratory rat. Therefore, modifications in this highly developed tactile sense could affect the behavioral response of subterranean *Ctenomys* to tests in general and to the EPM in particular. Again, the results of this study showed that vibrissal removal did not affect transparent arm exploration, but caused a clear maze exploration decrement, an expected outcome considering the important role that sensory stimuli play for navigation in this particular mammal group. Therefore, under the methodological conditions utilized in this work, it seems that, while the main indicators of anxiety remain relatively constant, the activity parameters (indirectly linked to anxiety) are affected by the two assessed variables, a situation that generates a call for attention to the validation of the EPM to assess behaviors under different methodological contexts. Of course, since several factors seem to influence the response of rodents at anxiety tests, we cannot exclude the possible impact of evaluating a wild species in an unfamiliar environment. Future studies should evaluate the effects of captivity, enriched environments and stressors on the behavioral profile of this species of subterranean rodent.

Conclusion

In conclusion, illumination conditions and vibrissal sense are both relevant factors that influence exploratory behavior in this species of subterranean rodent, although the conditions do not seem to influence the evaluation of anxiety levels in the EPM. Regarding the behavioral profile of different rodents on the EPM, it is clear that few studies have been conducted on the behavior of wild species on diverse tests of anxiety in general, and in the EPM in particular. Considering the results of this and other related studies, more research is necessary before drawing any general picture about EPM protocols in rodents, including species with different lifestyles and activity patterns. As a general recommendation, considering the biological characteristics of each species and evaluating their behavioral response under diverse experimental conditions is desirable before evaluations of anxiety and exploratory behaviors.

Availability of data

The data that support the findings of this study are available from the corresponding author (Schleich Cristian, cschleic@mdp.edu.ar) upon reasonable request.

Availability of analytic methods

The entire set of analytical methods supporting the results of this study are available through request to contact the corresponding author (Schleich Cristian, cschleic@mdp.edu.ar) upon reasonable request.

Availability of materials

The entire set of materials supporting the results of this study is available from the corresponding author (Schleich Cristian, cschleic@mdp.edu.ar) upon reasonable request.

Conflicts of interest declaration

The author declares no competing interests.

References

Becerra Garcia M. A., Cardenas F. P., & Morato S. (2005). Effect of different illumination levels on rat behavior in the elevated plus-maze. *Physiology and Behavior, 85*(3), 265-270. https://doi.org/10.1016/j.physbeh.2005.04.007

Becker, A., & Grecksch, G. (1996). Illumination has no effect on rats' behavior in the elevated plus-maze. *Physiology and Behavior,* 59, 1175–1177. https://doi.org/10.1016/0031-9384(95)02224-4

Belzung, C. (1999). Measuring rodent exploratory behavior. In W. E. Crusio & R. T. Gerlai (Eds.), *Techniques in the Behavioral and Neural Sciences* (pp. 738-749). https://doi.org/10.1016/S0921-0709(99)80057-1

Boguszewski, P., & Zagrodzka, J. (2002). Emotional changes related to age in rats--a behavioral analysis. *Behavioural Brain Research, 133*(2), 323–332. https://doi.org/10.1016/S0166-4328(02)00018-9

Brachetta, V., Schleich C. E., & Zenuto, R. R. (2015). Short-term anxiety response of the subterranean rodent *Ctenomys talarum* to odors from a predator. *Physiology and Behavior, 151*, 596–603. https://doi.org/10.1016/j.physbeh.2015.08.021

Brachetta, V., Schleich, C. E., & Zenuto, R. R. (2016). Source odor, intensity, and exposure pattern affect antipredatory responses in the subterranean rodent Ctenomys talarum. *Ethology, 122*, 923–936. https://doi.org/10.1111/eth.12568

Busch C., Antinuchi D., Del Valle J., Kittlein M., Malizia A., Vassallo A., & Zenuto, R. (2000) Population ecology of subterranean rodents. In E. Lacey, J. Patton, & G. Cameron (Eds.) *Life underground: the biology of subterranean rodents* (pp. 183-226). University of Chicago Press.

Carobrez A. P., & Bertoglio L. J. (2005). Ethological and temporal analyses of anxiety-like behavior: the elevated plus-maze model 20 years on. *Neuroscience and Biobehavioral Reviews, 29*(8),1193-1205. https://doi.org/10.1016/j.neubiorev.2005.04.017

Carola, V., D'Olimpio, F., Brunamonti, E., Mangia, F., & Renzi, P. (2002). Evaluation of the elevated plus-maze and open-field tests for the assessment of anxiety-related behaviour in inbred mice. *Behavioural Brain Research, 134*, 49-57. https://doi.org/10.1016/S0166-4328(01)00452-1

Fanjul, M. S., Cutrera, A. P., Luna, F., Schleich, C. E., Brachetta, V., Antenucci, C. D., & Zenuto R. R. (2021). Ecological Physiology and Behavior in the *Genus Ctenomys*. In T. R. O. d Freitas, G. L. Gonçalves, & R. Maestri (Eds.) *Tuco-Tucos* (pp. 221-247). Springer.

Filgueiras, G. B., Carvalho-Netto, E. F., & Estanislau, C. (2014). Aversion in the elevated plus-maze: Role of visual and tactile cues. *Behavioural Processes*, *107*, 106-111. https://doi.org/10.1016/j.beproc.2014.08.005

Grigoryan, G., Hodges, H., & Gray, J. (2005). Effects of Vibrissae Removal on Search Accuracy in the Water Maze. *Neuroscience and Behavioral Physiology,* 35(2), 133-137. https://doi.org/10.1007/s11055-005-0052-y

Hite, N. J., Sudheimer, K. D., Anderson, L., & Sarko, D. K. (2022). Spatial Learning and Memory in the Naked Mole-Rat: Evolutionary Adaptations to a Subterranean Niche. *Frontiers in Ecology and Evolution*, *10*, Article 879989. https://doi.org/10.3389/fevo.2022.879989

Jones, N., & King, S. M. (2001). Influence of circadian phase and test illumination on pre-clinical models of anxiety. *Physiology and Behavior,* 72, 99–106. https://doi.org/10.1016/S0031-9384(00)00388-7

Kapogiannatou, A., Paronis, E., Paschidis, K., Polissidis, A., & Kostomitsopoulos, N. G. (2016). Effect of light colour temperature and intensity on the behaviour of male C57CL/6J mice. *Applied Animal Behaviour Science, 184*, 135-140. https://doi.org/10.1016/j.applanim.2016.08.005

Kimchi, T., & Terkel, J. (2004). Comparison of the role of somatosensory stimuli in maze learning in a blind subterranean rodent and a sighted surface-dwelling rodent. *Behavioural Brain Research,* 153, 389-395. https://doi.org/10.1016/j.bbr.2003.12.015

Kimchi, T., Etienne, A. S., & Terkel, J. (2004). A subterranean mammal uses the magnetic compass for path integration. *Proceedings of the National Academy of Sciences, 101*(4), 1105–1109. https://doi.org/10.1073/pnas.0307560100

Kott, O., Šumbera, R., & Němec, P. (2010). Light Perception in Two Strictly Subterranean Rodents: Life in the Dark or Blue? *PLoS ONE, 5*(7), Article e11810. https://doi.org/10.1371/journal.pone.0011810

Manaf, P., Morato, S., & Spinelli Oliveira, E. (2003). Profile of wild Neotropical spiny rats (*Trinomys*, Echimyidae) in two behavioral tests. *Physiology and Behavior, 79*(2), 129-133. https://doi.org/10.1016/S0031-9384(03)00121-5

Martínez, J. C., Cardenas, F., Lamprea, M., & Morato, S. (2002). The role of vision and proprioception in the aversion of rats to the open arms of an elevated plus-maze. *Behavioural Processes*, 60, 15-26. https://doi.org/10.1016/S0376-6357(02)00102-X

Morato Andrade, M. M., Tomé, M. F., Santiago, E. S., Lúcia-Santos, A., & Carneiro Spera de Andrade, T. G. (2003). Longitudinal study of daily variation of rats' behavior in the elevated plus-maze. *Physiology and Behavior,* 78(1), 125-133. https://doi.org/10.1016/S0031-9384(02)00941-1

Pellow, S., Chopin, P., File, S. E., & Briley, M. (1985). Validation of open: closed arm entries in an elevated plus-maze as a measure of anxiety in the rat. *Journal of Neuroscience Methods, 14*(3), 149-167. https://doi.org/10.1016/0165-0270(85)90031-7

Reig, O. A., Busch, C., Ortells, M. O., & Contreras, J. R. (1990) An overview of evolution, systematics, population biology, cytogenetics, molecular biology, and speciations in Ctenomys. In E. Nevo & O. A. Reig (Eds.) *Evolution of subterranean mammals at the organismal and molecular levels* (pp. 71-96). Wiley-Liss.

Rico, J. L., Muñoz-Tabares, L. F., Lamprea, M. R., & Hurtado-Parrado, C. (2019). Diazepam Reduces Escape and Increases Closed-Arms Exploration in Gerbils After 5 min in the Elevated Plus-Maze. *Frontiers in Psychology,10*, Article 748. https://doi.org/10.3389/fpsyg.2019.00748

Shishelova, A. Y. (2006). Effect of whisker removal on defensive behavior in rats during early ontogenesis. *Neuroscience and Behavioral Physiology,* 36, 883–888. https://doi.org/10.1007/s11055-006-0102-0

Võikar, V., Kõks, S., Vasar, E., & Rauvala, H. (2001). Strain and gender differences in the behavior of mouse lines commonly used in transgenic studies.

Physiology and Behavior, 72, 271-281. https://doi.org/10.1016/S0031-9384(00)00405-4

Walf A. A., & Frye C. A. (2007). The Use of the Elevated plus Maze as an Assay of Anxiety-Related Behavior in Rodents. *Nature Protocols, 2*, 322-328. https://doi.org/10.1038/nprot.2007.44