Can humans use local landmarks in a virtual environment?

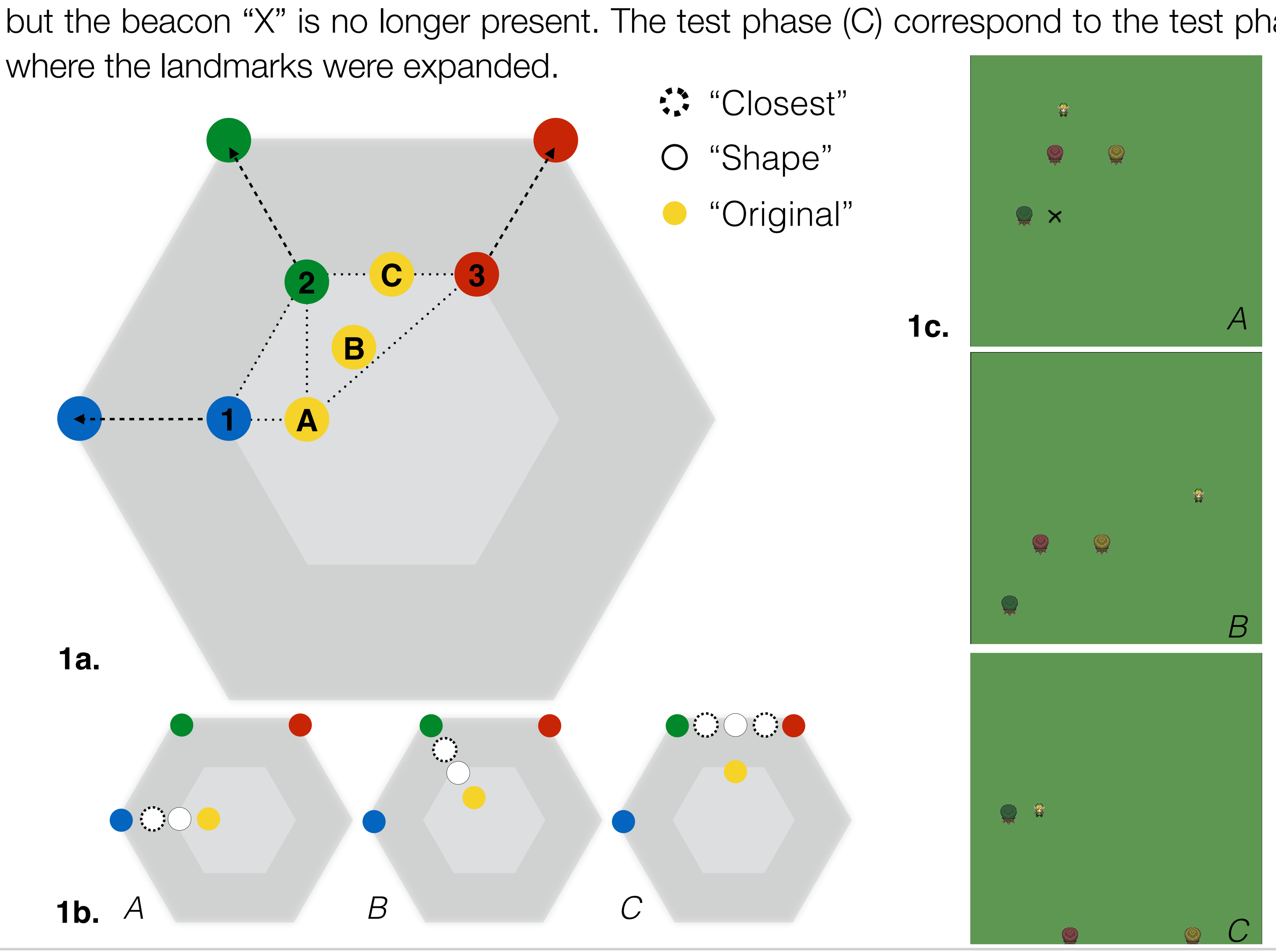
Rodrigo Alejandro*, Buriticá Jonathan & Avila-Chauvet Laurent
Centro de Estudios e Investigaciones en Comportamiento, Universidad de Guadalajara

Introduction

It is known that mammals use landmarks in their environment to locate sites of biological relevance, such as food patches, shelter or reproductive areas[1]. These sites are best known as goals or reinforcement areas. It has been observed in humans that landmark proximity and prominence in relation to a target area, defines the strategy used by us to situate in a virtual space[2]. However, when it has been investigated whether humans are guided by a single landmark or by multiple, the evidence points in two different directions. One suggests that humans used a single landmark to locate ourselves in the environment[3]; the second, sustains that we guide our course by following a global arrangement of landmarks[4]. The aim of this research was to establish whether humans follow one or multiple cues presented in a virtual environment by examine if the participants weighted the proximity of the landmarks with the goal. The task developed by Pritchard, et. al. (2016) allows to evaluate both hypothesis by presenting three landmarks in relation to three goals (depending on the group) during training and expanding the global arrangement in the test phase. For that reason we use and adapted a version of the protocol proposed by the afforded mentioned authors.

Method

1a. Geometric layout of the virtual environment. The small hexagon (i.e. light gray) represents the landmark arrangement during the training phase. Landmarks are represented by circles 1, 2 and 3 and the goal by the yellow circles (A, B and C) depending on the group. The largest hexagon (i.e. dark gray) represents the expansion of the landmarks during the test phase. **1b.** The image represents three hypothetical response sites during the test phase. The dotted white circle shows a response guided by the proximity to one landmark, the continuous white circle displays a response regulated by the global landmark arrangement and the yellow circle exhibit the reinforcement site experienced in the training phase. **1c.** This picture shows three virtual rooms displayed to the participants. The first part of the training phase (A) shows the position of the goal (i.e. chest) represented by the "X", the second stage (B) maintains the same landmark arrangement but the beacon "X" is no longer present. The test phase (C) correspond to the test phase where the landmarks were expanded.



Discussion

The results of this experiment show that all participants have used the virtual landmarks to found the goal during the test as a result of a shift on the location where they search for the reward compared to the training phase, similar to hummingbirds.

The distribution of responses and the pattern of search when the goal locates at different distances from each landmark (Group A), seems to show a preference to the closest landmark (1) in comparison to the global arrangement. Interestingly, while hummingbirds try to compensate the error of the previous choices by pointing towards the correct direction, humans seem to change the strategy facing a new site (3rd choice).

Opposed to hummingbirds who showed a strong preference for the previous reward site when the goal locates near landmark 2 and equally far from the other two (Group B), humans seemed to follow the overall shape of the array in all three choices.

Likewise hummingbirds, humans seem to show a strong preference in the first choice for the total arrangement of the cues when the goal is equally closed to two landmarks and far away from the third one (Group C), but unlike these birds who distributed evenly the location search between landmark 2 and 3 during the 2nd and 3rd choices, the human participants appear to follow just the second landmark, such as if they took into consideration the shape of the array.

When evaluating the euclidian distance between the landmarks and the goal, it could be suggested that is easier for the participants to locate more accurately the goal when the landmarks are at the same distance (groups B and C) compared to Group A, when the landmarks are at different distances. Even though there seem to be no significant differences between group A and B, the search path of group B seems to be located more towards the goal than towards the closest landmark.

As a result of this, it could be suggested that the participants of group A need a greater number of trials to complete the task compared to group B and C.

Our results suggest that hummingbirds and humans use different strategies to locate the goal even when they are exposed to a similar arrangement of cues. We can denote that humans attend more to the shape of the arrangement than a single landmark.

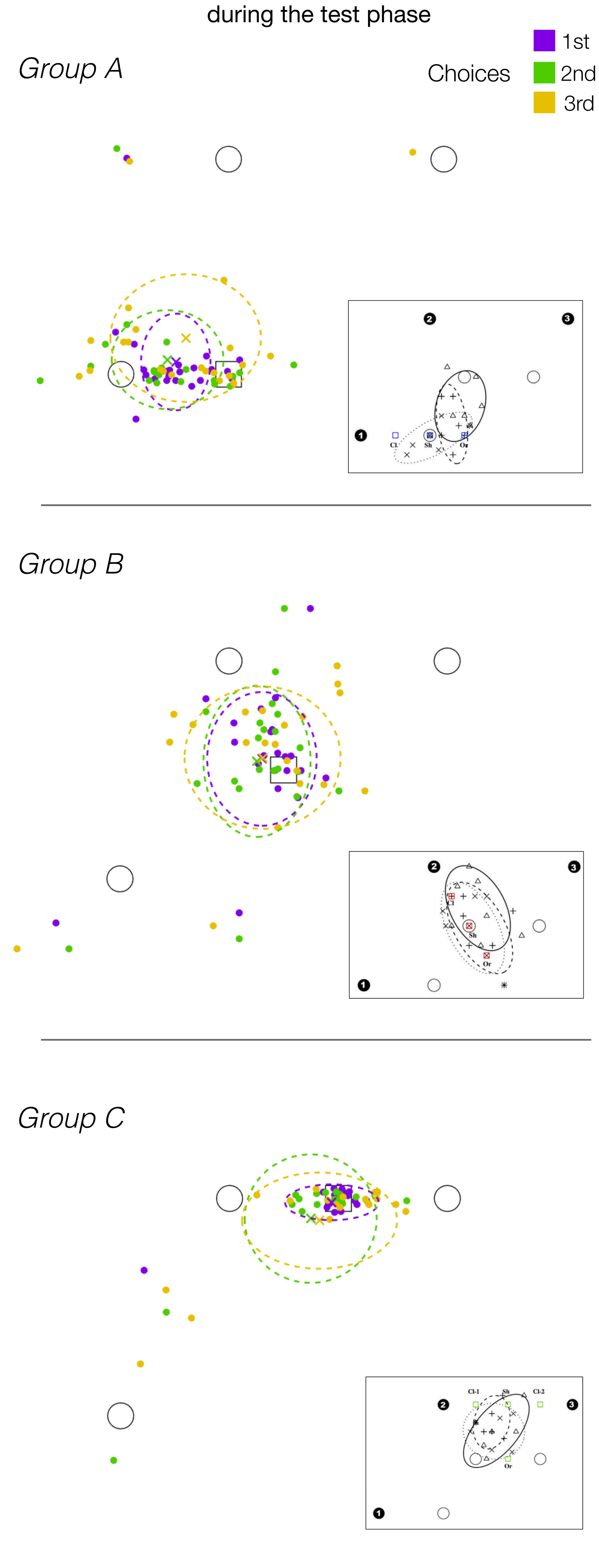
This research was funded by CONACyT trough the national scholarship program 291236 granted to AR. CVU / Scholar (592580/305977), and the support to the program for building and development of scientific and technological infrastructure (281265) to JB.

Correspondence: alejandrodrigo86@gmail.com

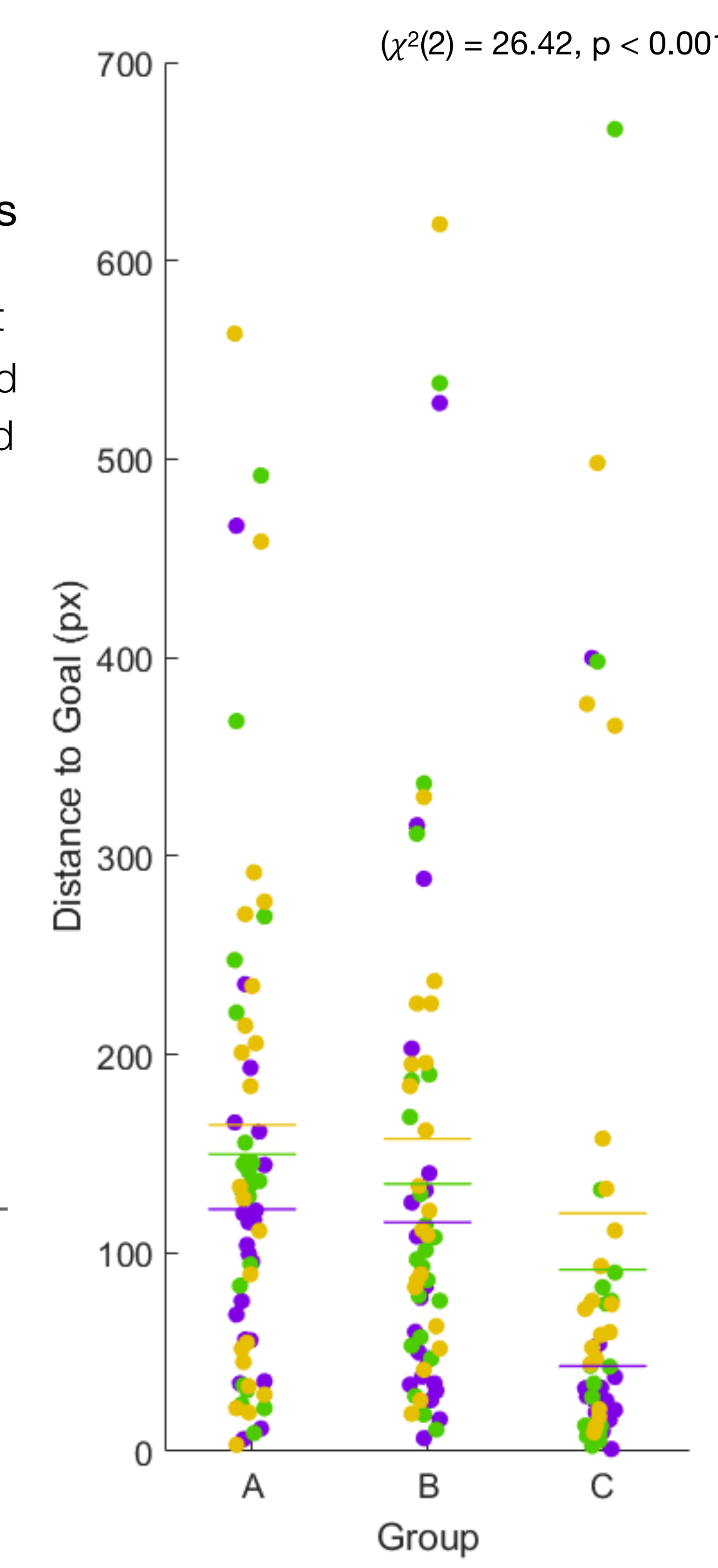
Results

3 groups n=62 participants

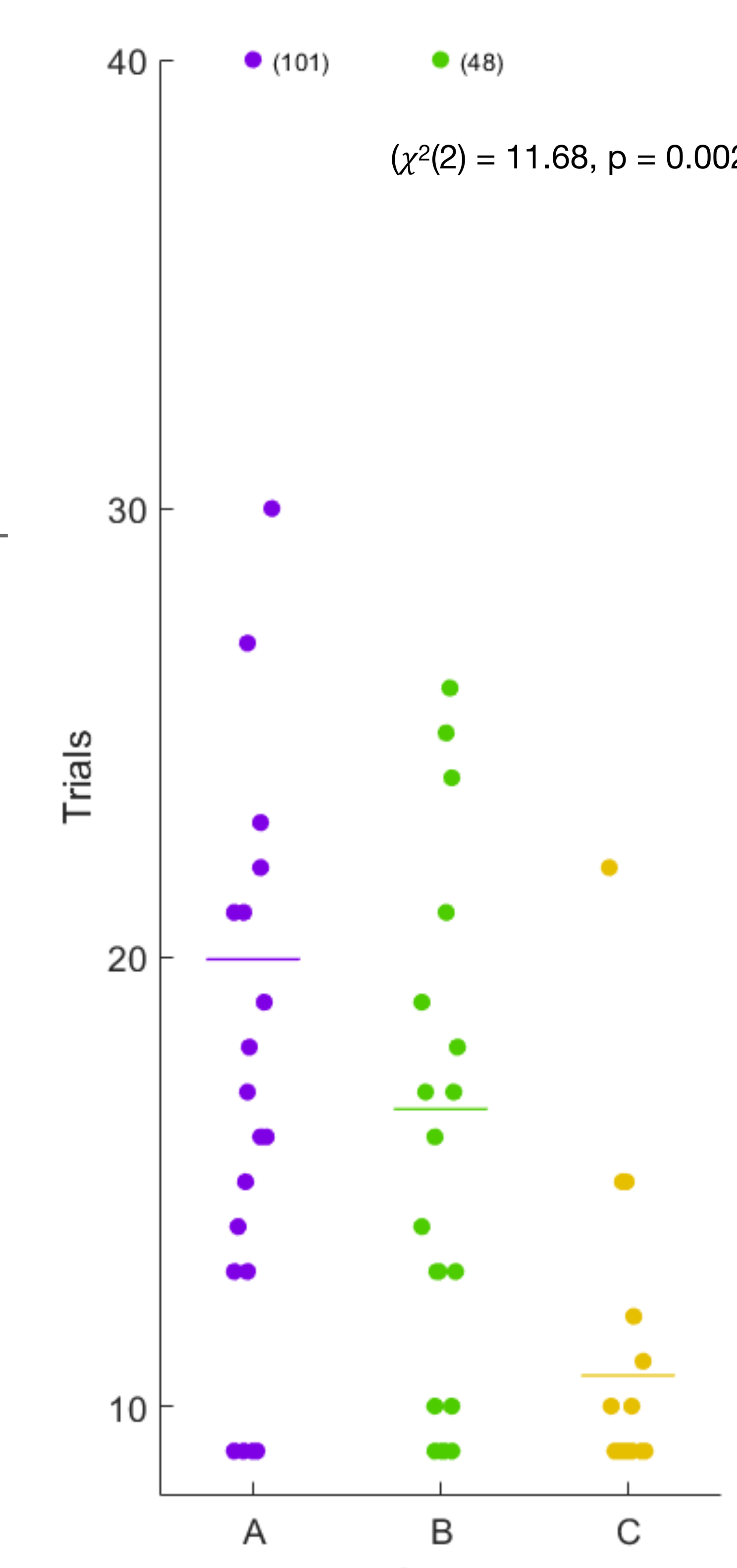
Mean locations of the first, second and third choices during the test phase



The graphics locate in the lower right corner shows the data from Pritchard, et. al. (2016), Fig. 4



*$z = 4.56$, $p < 0.001$ **$z = 4.33$, $p < 0.001$



*$z = 3.06$, $p = 0.002$ **$z = 2.9$, $p = 0.003$

References

[1] Leising, K. J., & Blaisdell, A. P. (2009). Associative basis of landmark learning and integration in vertebrates. *Comparative Cognition & Behavior Reviews*, *4*.
[2] Kelly, D. M., & Gibson, B. M. (2007). Spatial navigation: spatial learning in real and virtual environments. *Comparative Cognition & Behavior Reviews*, *2*.
[3] Steck, S. D., & Mallot, H. A. (2000). The role of global and local landmarks in virtual environment navigation. *Presence*, 9, 1, 69-83.
[4] Poore, J. C., & Bowers, C. (2016). Editorial: Virtual Environments as Study Platforms for Realistic Human Behavior. *Front. Psychol. 7: 1361. doi: 10.3389/fpsyg.*
[5] Pritchard, D. J., Scott, R. D., Healy, S. D., & Hurly, T. A. (2016). Wild rufous hummingbirds use local landmarks to return to rewarded locations. *Behavioural processes*, *122*, 59-66.