

Impact of visual and olfactory stimuli on oviposition site selection in the Mediterranean fruit fly, *Ceratitis capitata* (Tephritidae)



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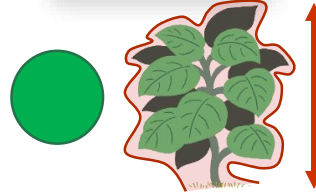
Context and issues

Choice of host plant by the female

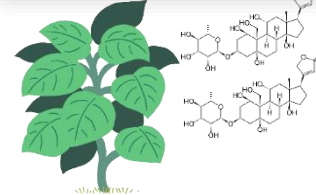
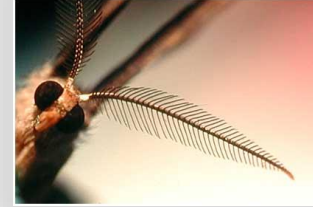


Effect on the fitness → effect on population dynamics^[1-4]

Visual



Olfactory



Gustatory and touch-sensitive^[5-7]



Context and issues

Choice of host plant by the female

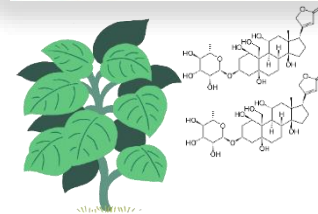
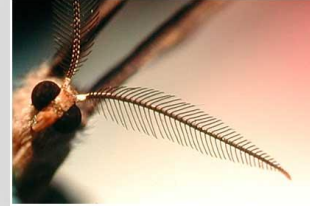


Effect on the fitness → effect on population dynamics^[1-4]

Visual



Olfactory



Gustatory and touch-sensitive^[5-7]

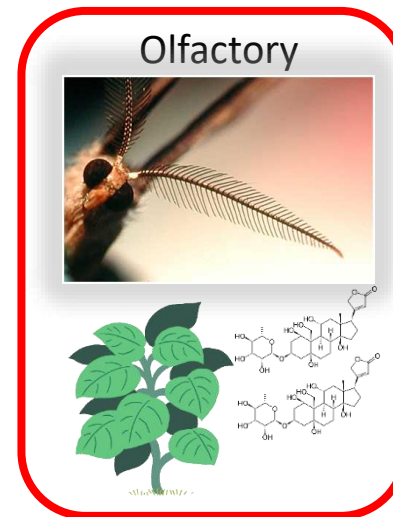
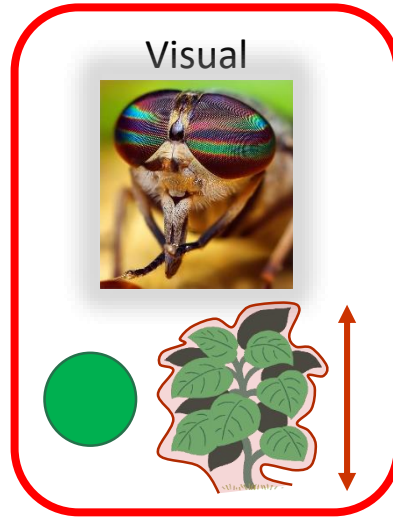


Context and issues

Choice of host plant by the female



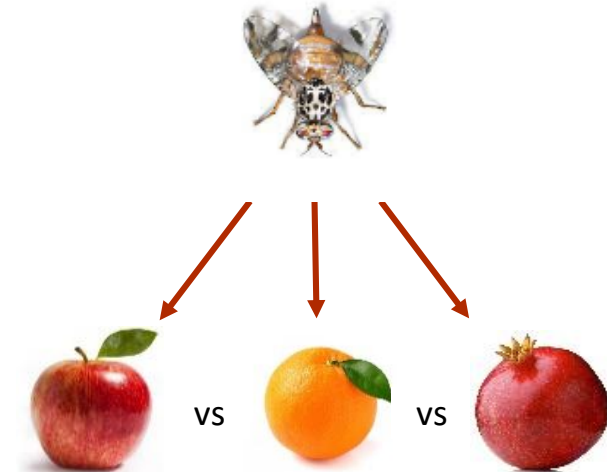
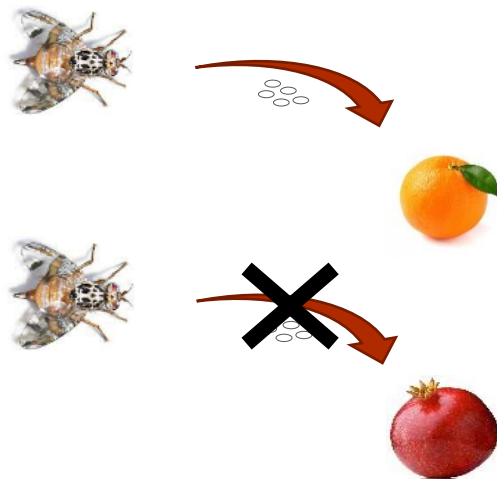
Effect on the fitness → effect on population dynamics^[1-4]



Gustatory and touch-sensitive^[5-7]



Acceptance vs preference



Acceptance = the female's natural tendency to lay eggs on a particular host when this is the only alternative available^[8]
→ measured by non-choice tests

Preference = the female's natural tendency to lay eggs on a particular host compared with her tendency to lay eggs on other available hosts^[8]
→ measured by choice tests

Context and issues

Phytophagous insects create damage on fruit trees



Context and issues

Phytophagous insects create damage on fruit trees



Chemical pesticides

Harmful to the environment
Resistance development in insects ^[9]



Context and issues

Phytophagous insects create damage on fruit trees



Chemical pesticides

Harmful to the environment
Resistance development in insects [9]



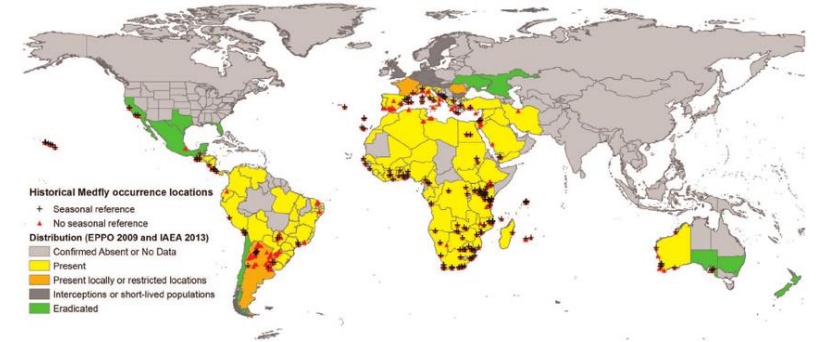
Develop sustainable and ecological control methods



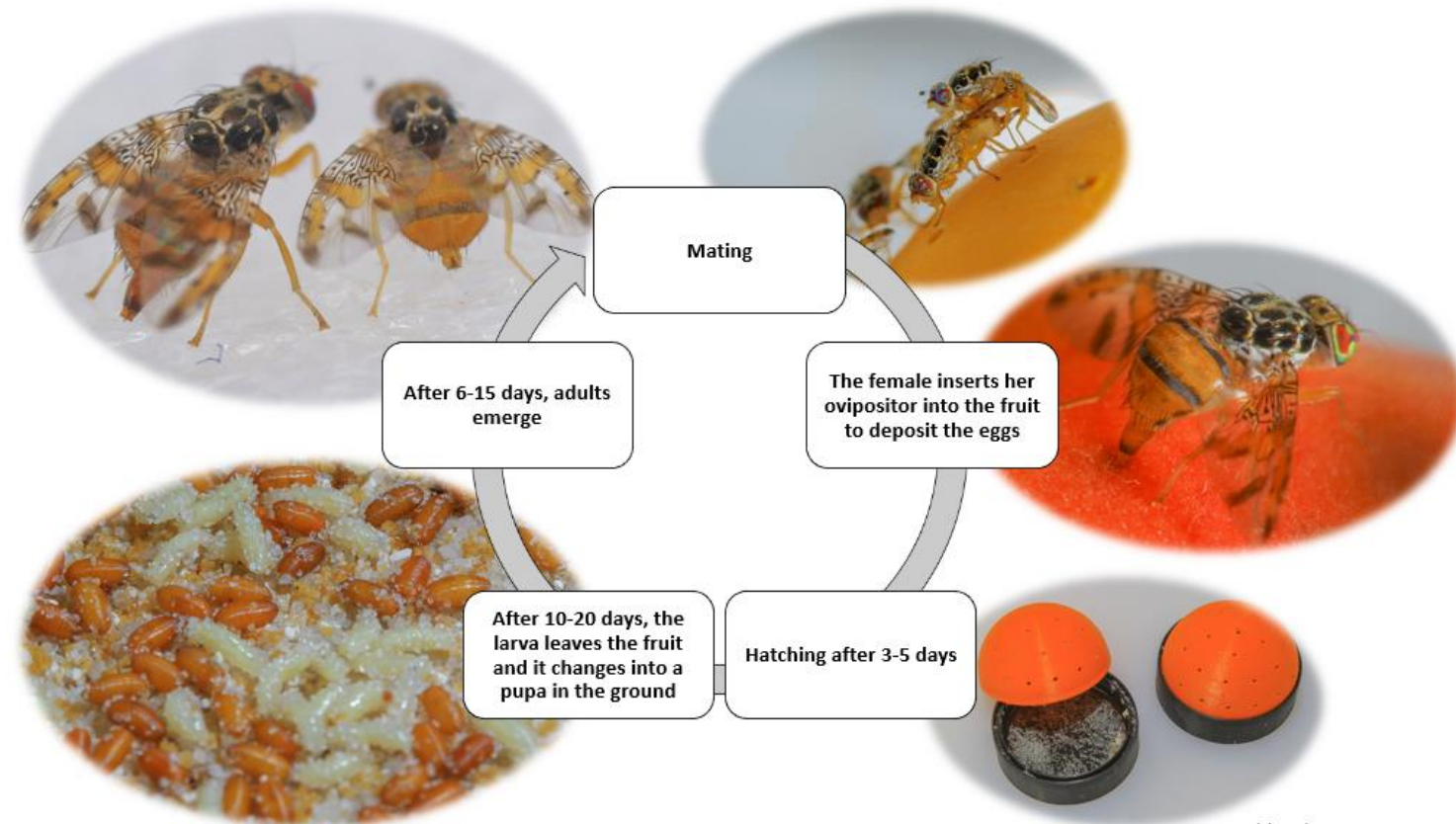
The Mediterranean fruit fly, *Ceratitis capitata* (Tephritidae)



- Large area of distribution
- Present in France
- Generalist species
- Causing considerable economic damages (attack commercially important fruits)



- Easy to rear in controlled conditions
- Possible manipulations of the different stages of the life cycle



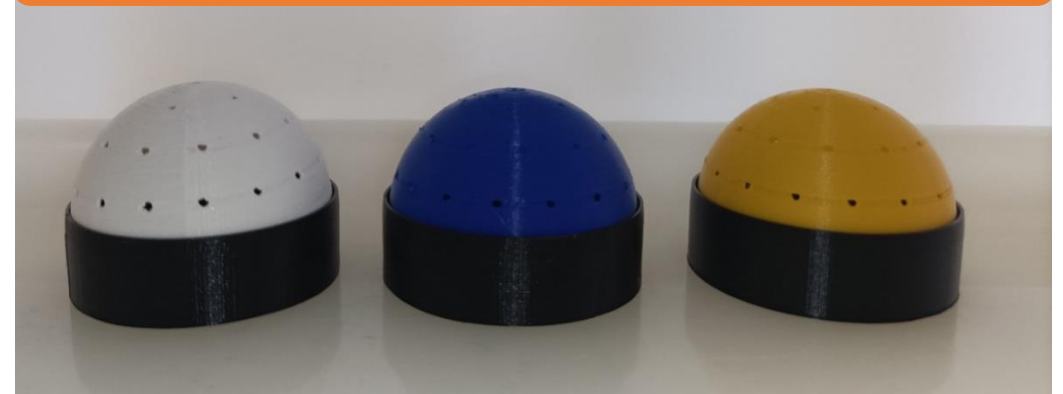
Visual and olfactory stimuli

Pre-manipulations



Visual stimuli (color, size, shape)

My internship



Visual stimuli → 3 colors



Olfactory stimuli



Olfactory stimuli → 3 odors

Protocol

- 9 modes * 7 repetitions = 63 cages
- 2 blocks * 2 measurements => 28 repetitions per modes
- 63 cages * 8 females = 504 females per block

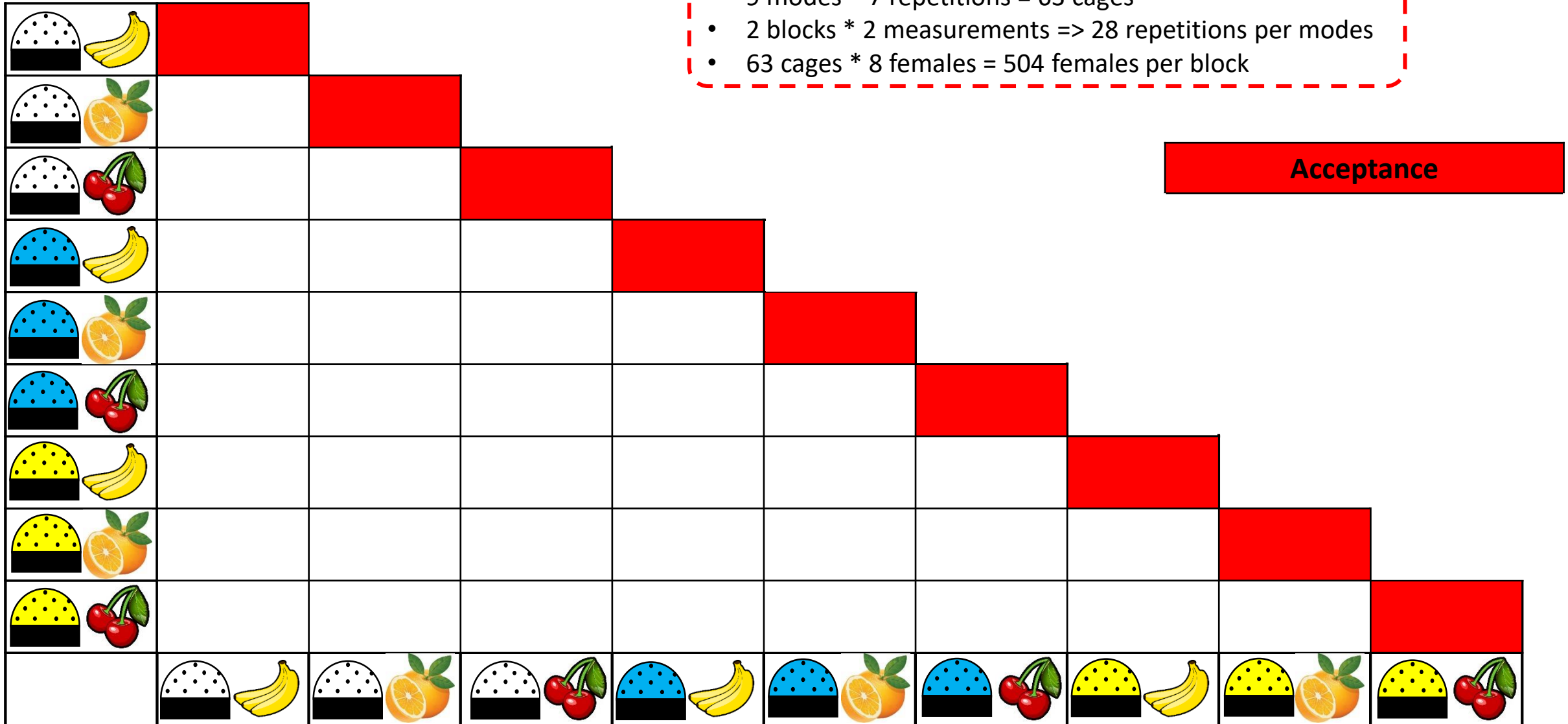


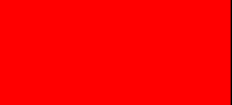







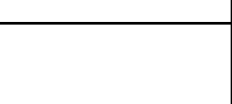





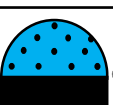

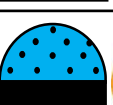

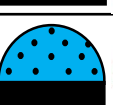

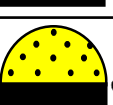
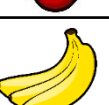
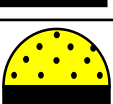

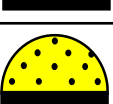



Table summarizing all the pairs of nest boxes allowing the interaction between olfactory and visual stimuli to be fully tested

Protocol

- 9 modes * 7 repetitions = 63 cages
- 2 blocks * 2 measurements => 28 repetitions per modes
- 63 cages * 8 females = 504 females per block







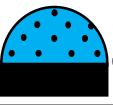





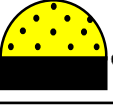



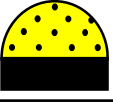

 	         								
 									
 									
 									
 									
 									
 									
 									
 									

Acceptance
Color preference

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 	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 100%; height: 100%; background-color: red; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: gray; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: red; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: gray; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: red; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: gray; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: red; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: gray; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: red; margin-bottom: 2px;"></div> <div style="width: 100%; height: 100%; background-color: gray; margin-bottom: 2px;"></div> </div>								
 									
 									
 									
 									
 									
 									
 									
 									

Acceptance
Color preference
Odor preference

Table summarizing all the pairs of nest boxes allowing the interaction between olfactory and visual stimuli to be fully tested

Protocol

- 18 modes * 4 repetitions = 72 cages
- 4 blocks * 2 measurements => 32 repetitions per modes
- 72 cages * 8 females = 576 females per block

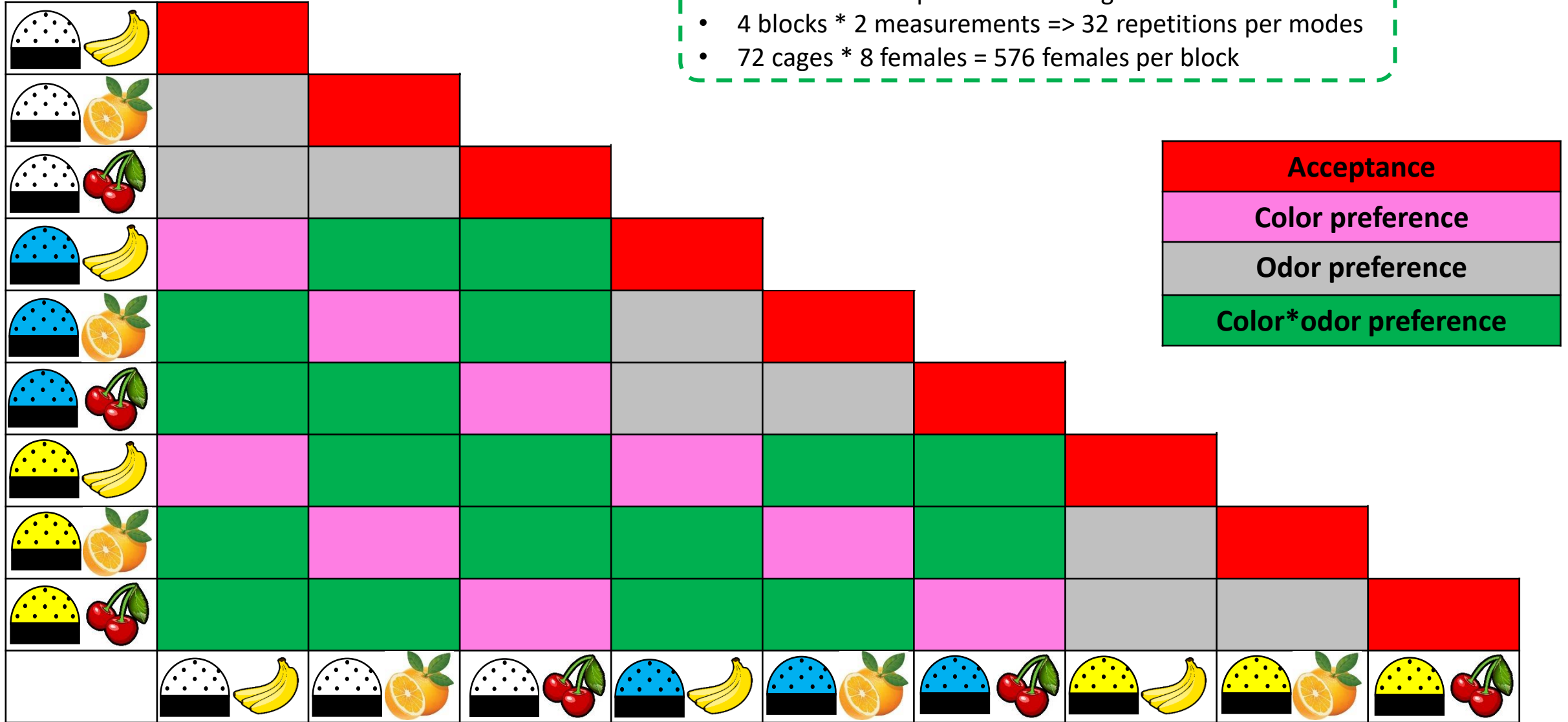
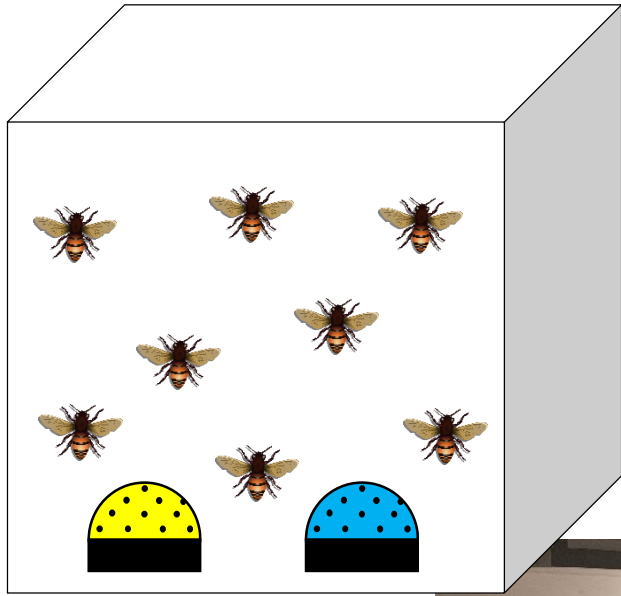


Table summarizing all the pairs of nest boxes allowing the interaction between olfactory and visual stimuli to be fully tested

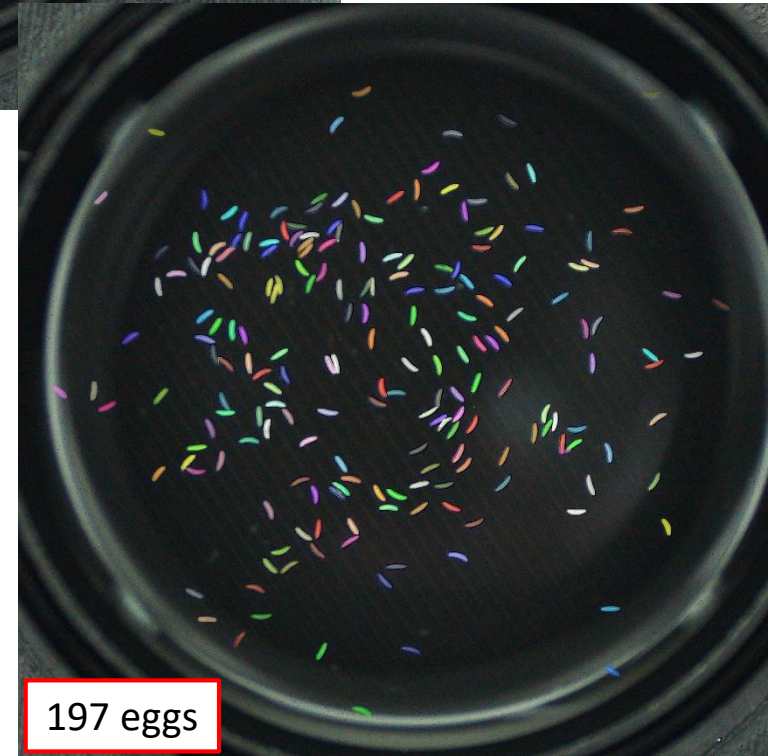
Protocol



Egg-laying during
4h



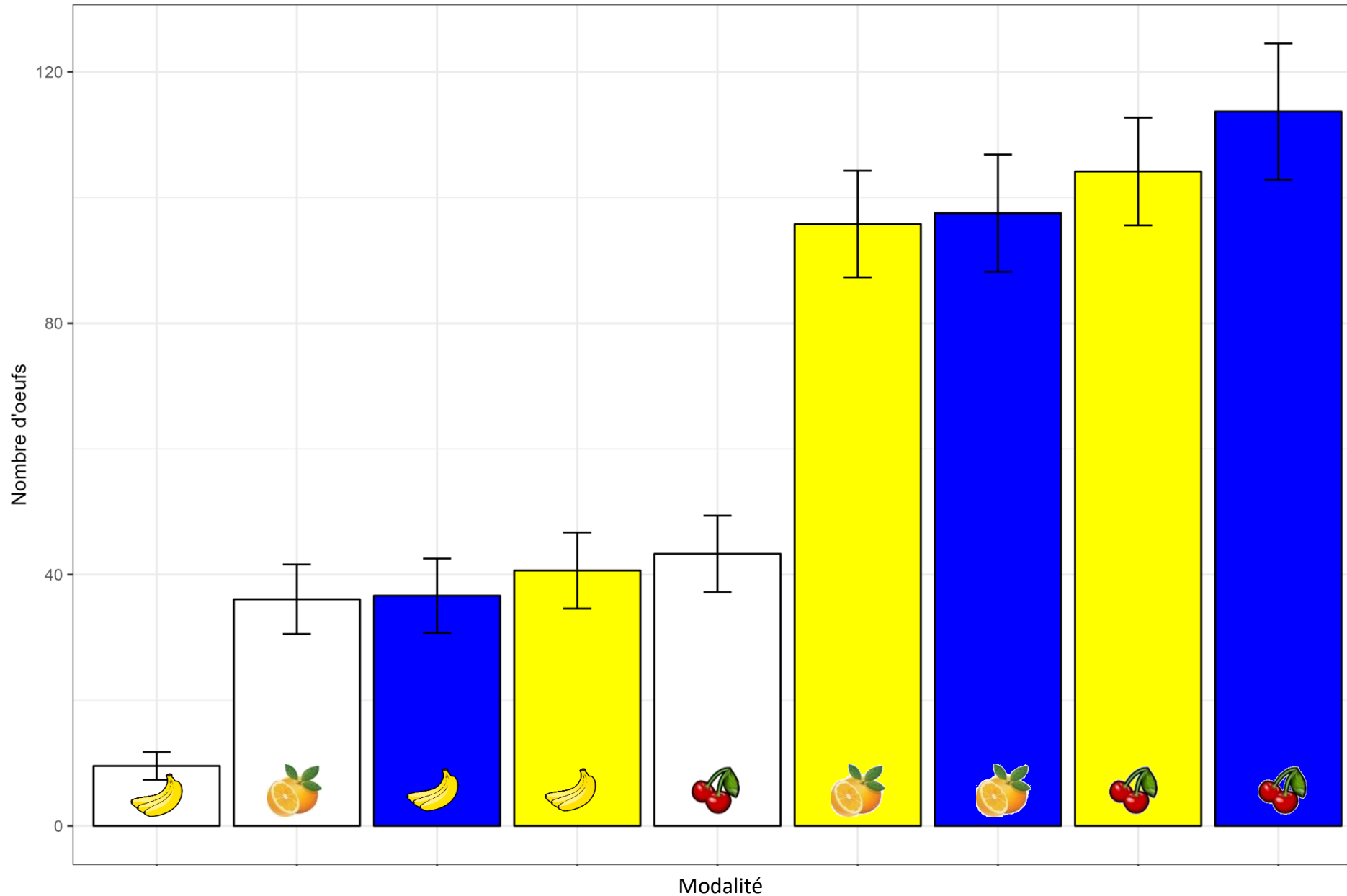
Artificial
intelligence



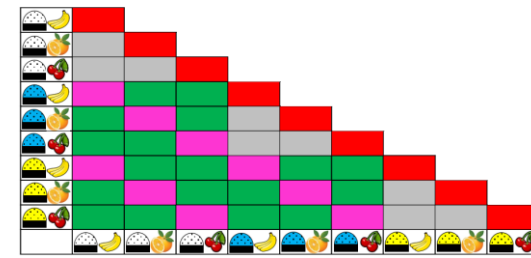
197 eggs

Results

Question : Do females detect different colors and odors?



Number of eggs according to the different types of nest boxes



Different numbers of eggs according to different colors and odors
→ Females discern colors and odors.

Question : Acceptance = preference ?

Reminder :

- Acceptance = experience of no choice
- Preference = experience of choice

Method

Estimation of EXPECTED preferences













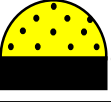



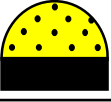









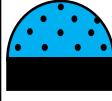

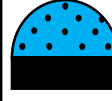



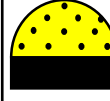

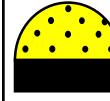

 									
 									
 									
 									
 									
 									
 									
 									
 									
	 	 	 	 	 	 	 	 	 

Table summarizing all the pairs of artificial oviposition devices allowing the interaction between olfactory and visual stimuli to be fully tested

Method

Estimation of EXPECTED preferences

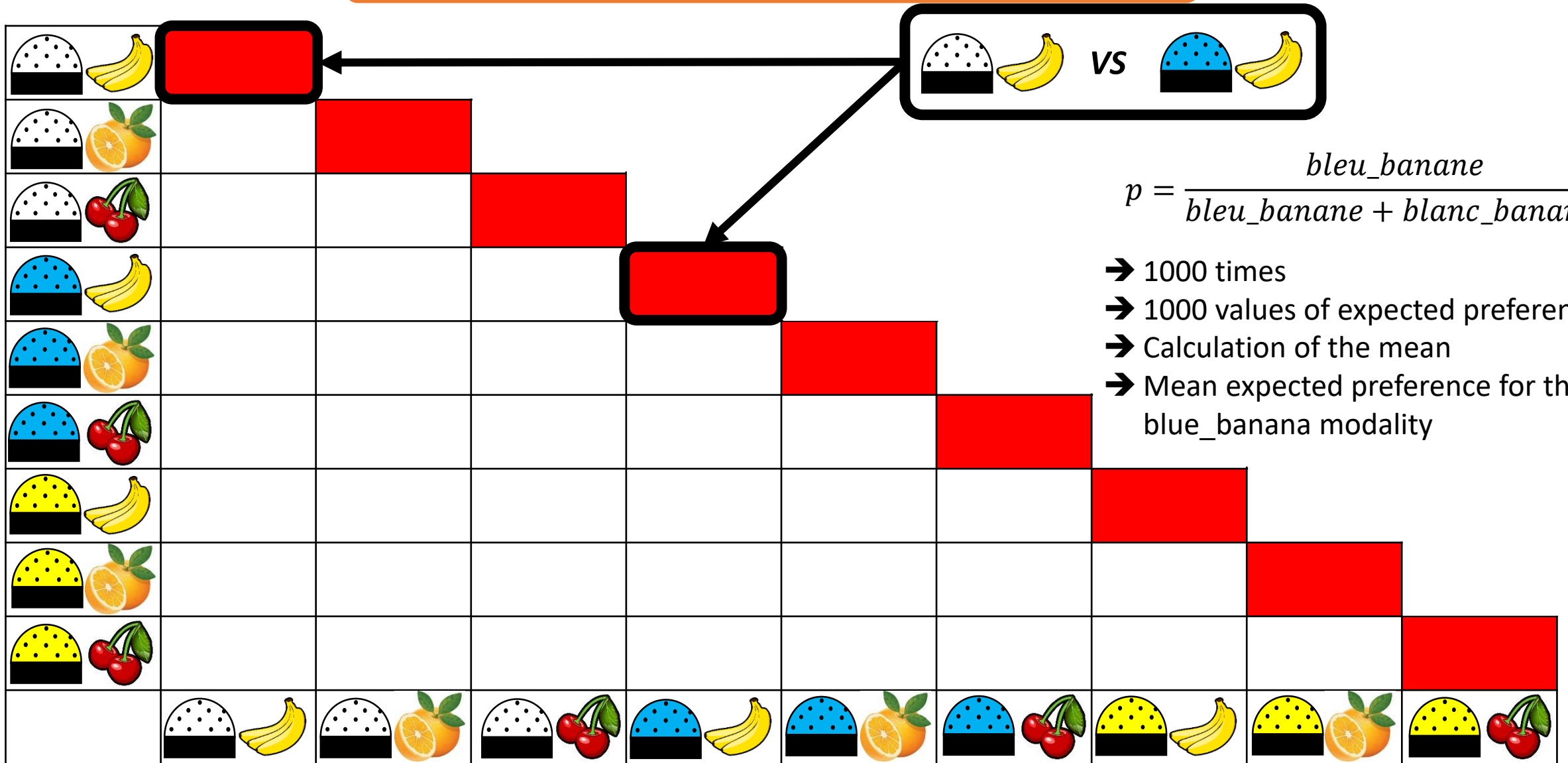
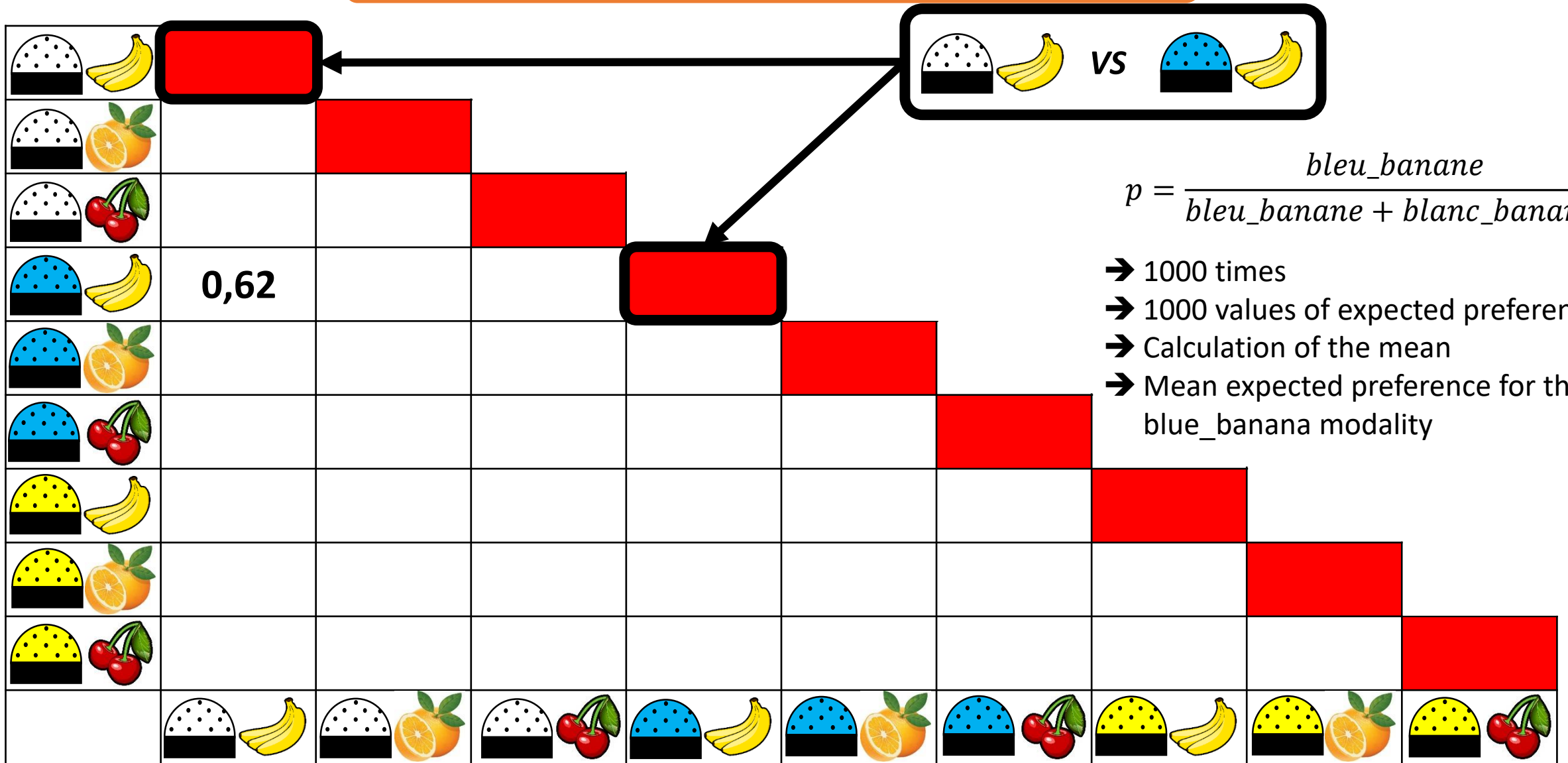


Table summarizing all the pairs of artificial oviposition devices allowing the interaction between olfactory and visual stimuli to be fully tested

Method

Estimation of EXPECTED preferences



[10]

Table summarizing all the pairs of artificial oviposition devices allowing the interaction between olfactory and visual stimuli to be fully tested

Method

Estimation of EXPECTED preferences

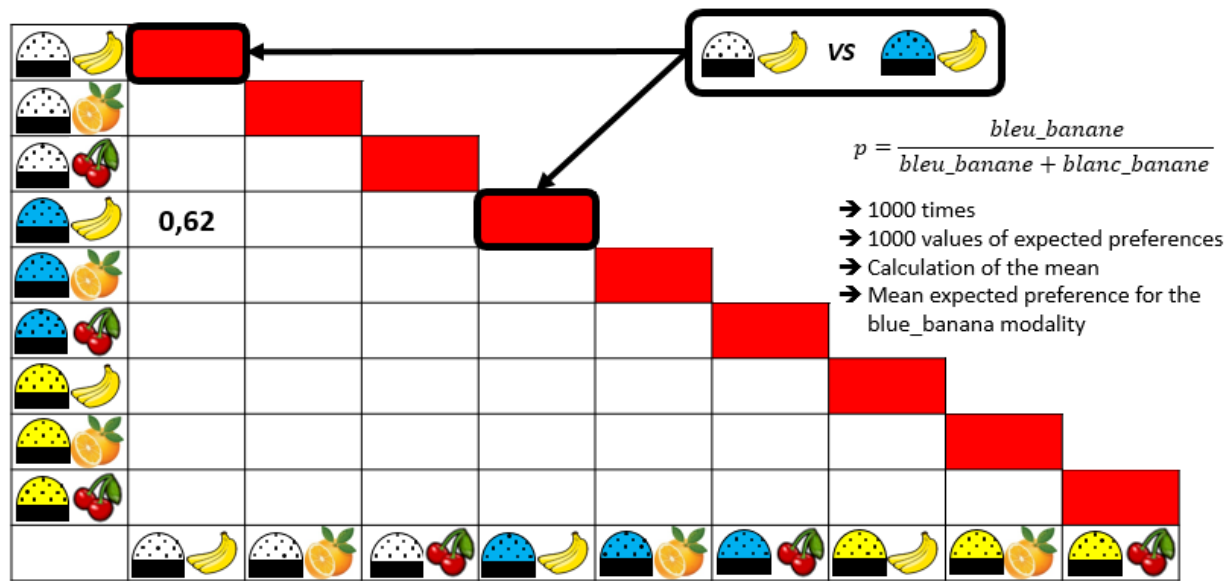


Table summarizing all the pairs of artificial oviposition devices allowing the interaction between olfactory and visual stimuli to be fully tested

Calculation of OBSERVED preferences

$$p = \frac{\text{nb oeufs pondoir 1}}{\text{nb oeufs pondoir 1} + \text{nb oeufs pondoir 2}}$$

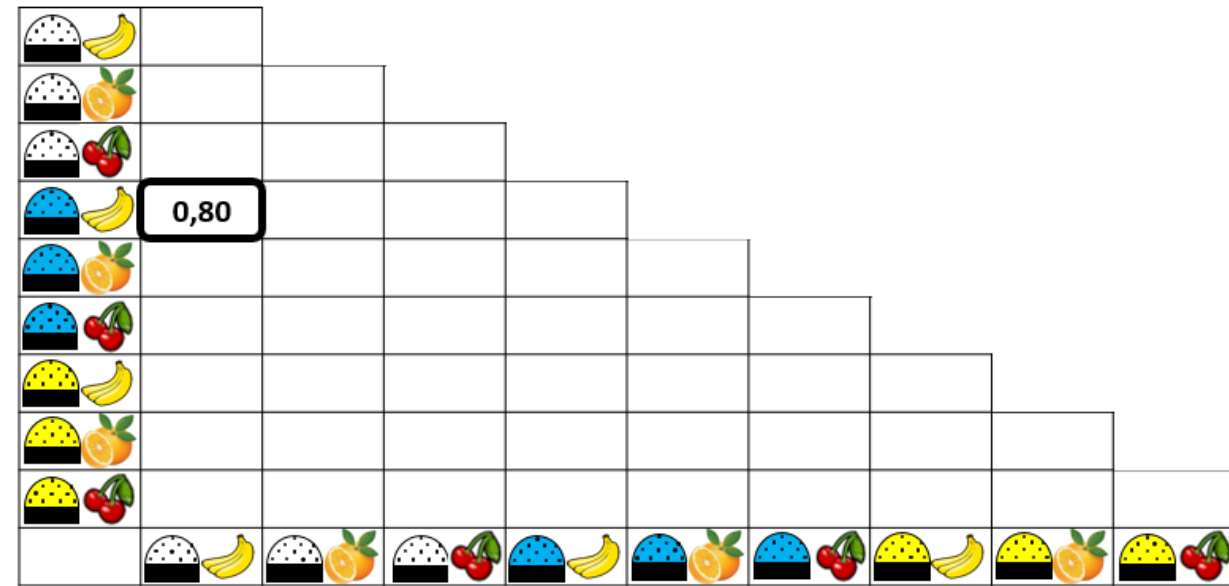
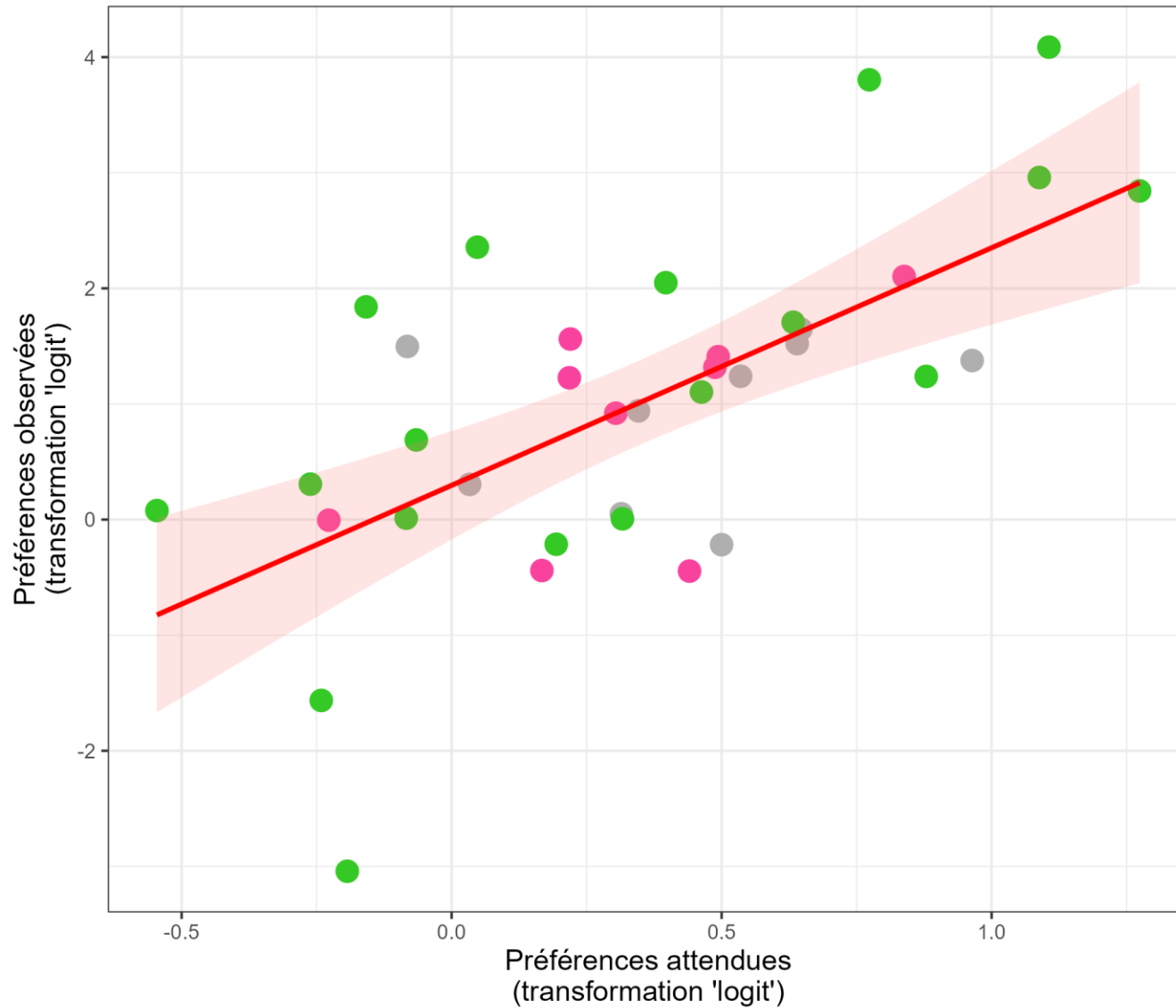


Table summarizing all the pairs of artificial oviposition devices allowing the interaction between olfactory and visual stimuli to be fully tested

Results

Question : Acceptance = preference ?



Conditions d'expérimentation

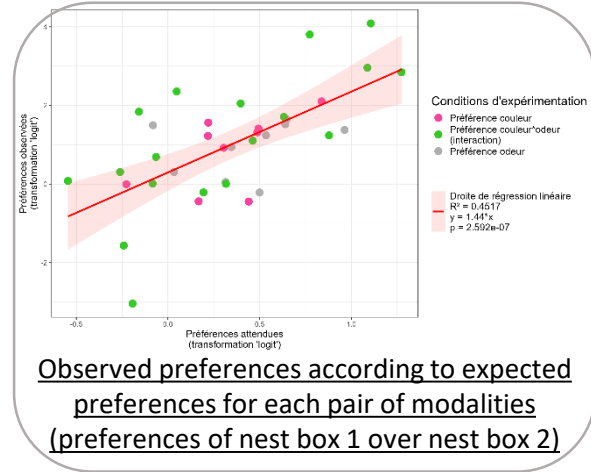
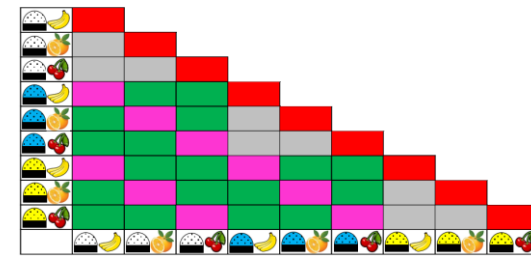
- Préférence couleur
- Préférence couleur*odeur (interaction)
- Préférence odeur

— Droite de régression linéaire
 $R^2 = 0.4517$
 $y = 1.44 * x$
 $p = 2.592e-07$

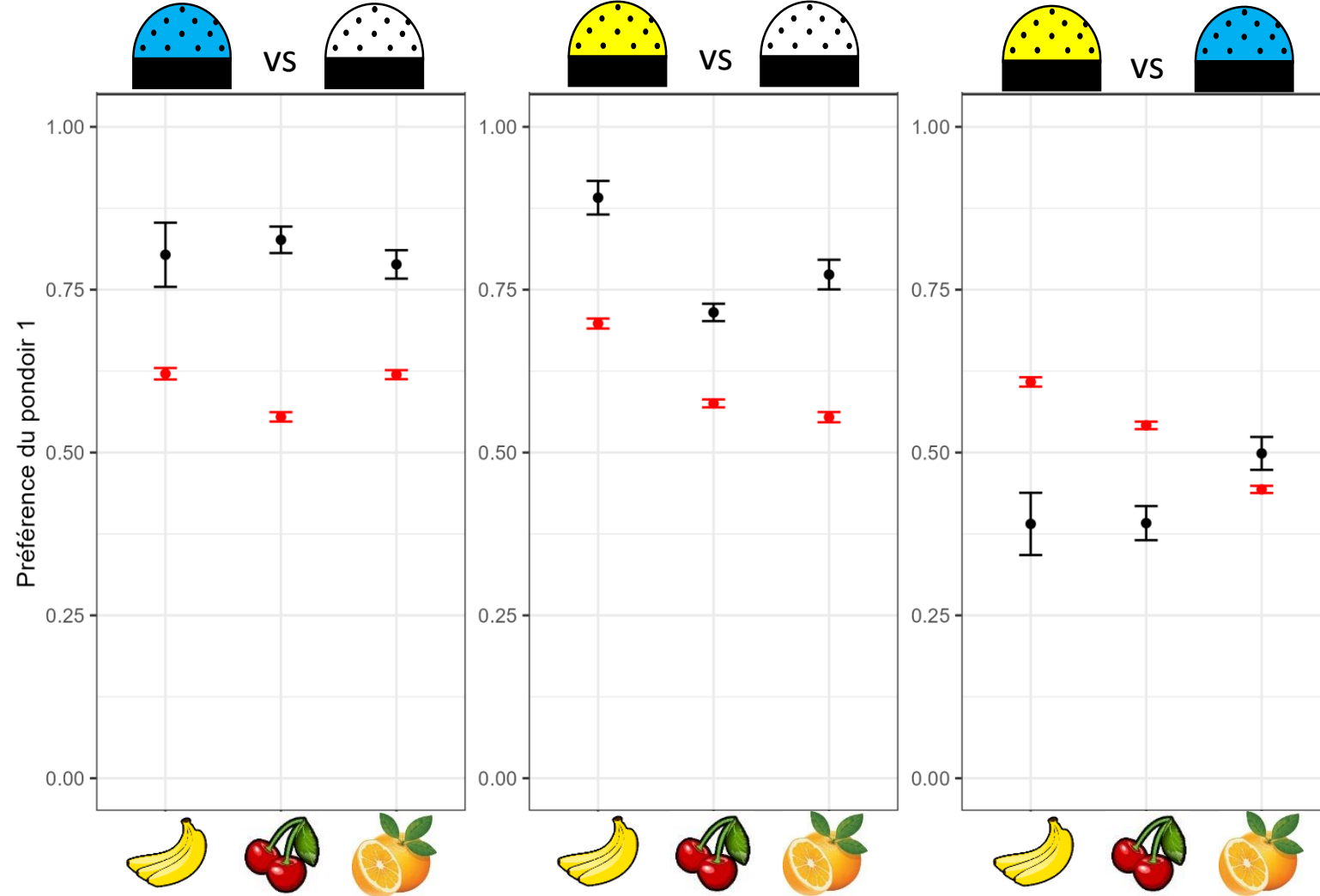
Observed preferences according to expected preferences for each pair of modalities
(preferences of nest box 1 over nest box 2)

Results

Question : Acceptance = preference ?



Observed preferences according to expected preferences for each pair of modalities (preferences of nest box 1 over nest box 2)



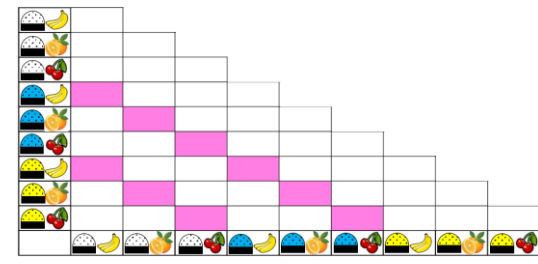
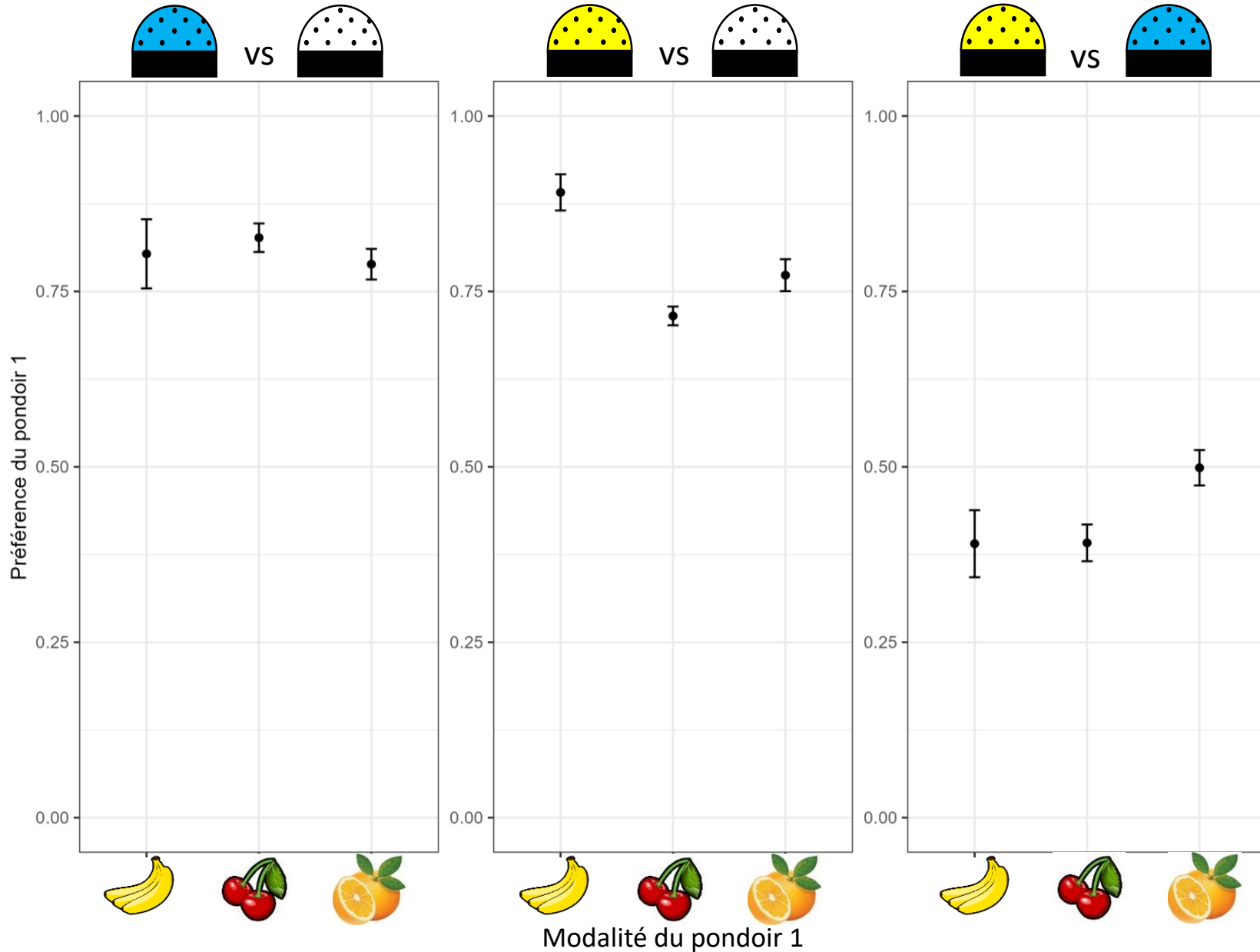
Légende

- Préférences attendues
- Préférences observées

Expected (in red) and observed (in black) preferences of nest box 1 over nest box 2 according to the different modes (choice experiment to test "color preference")

Results

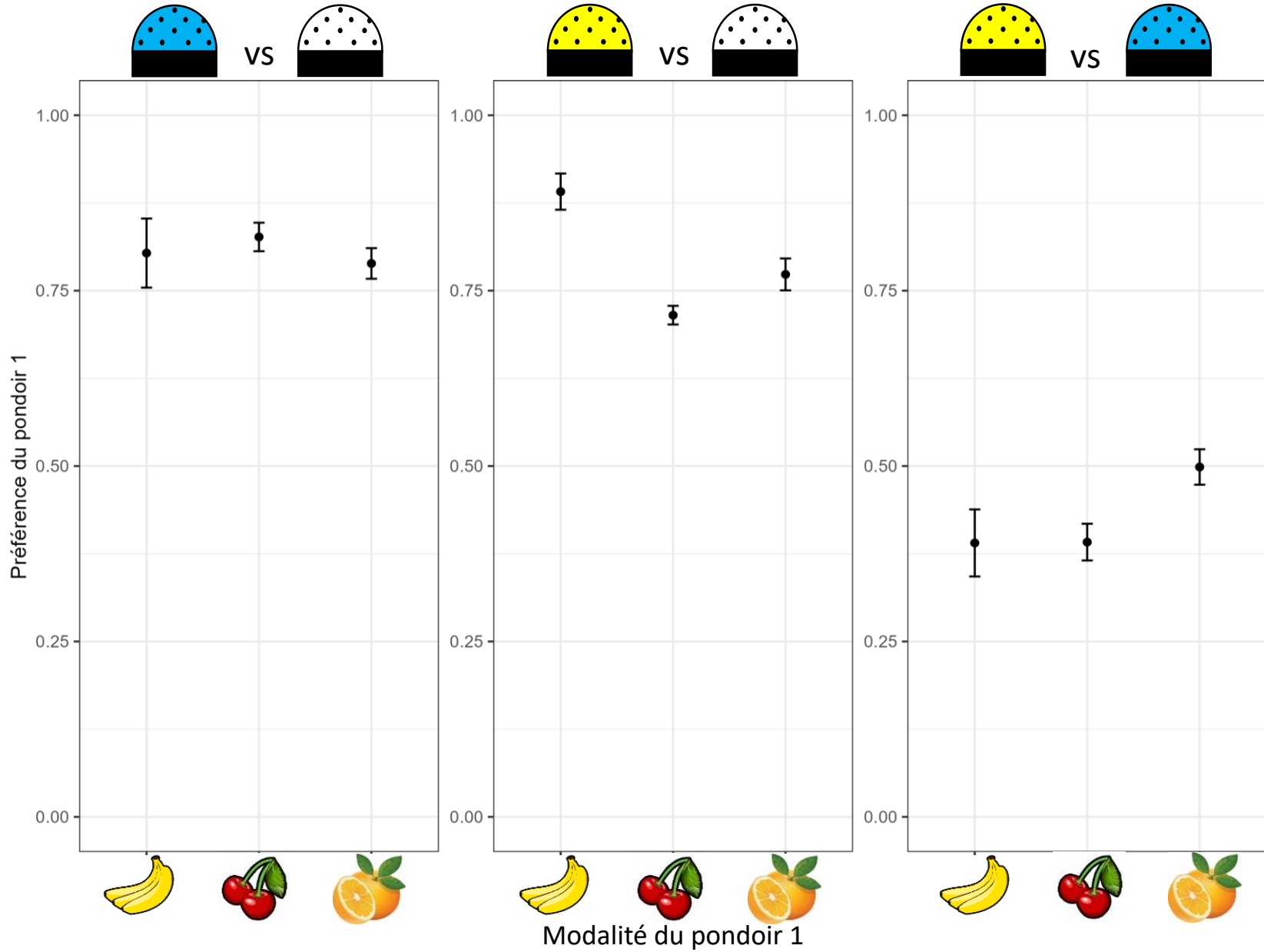
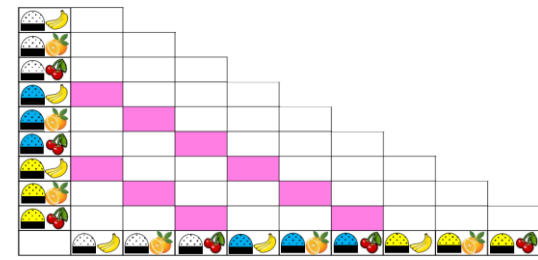
Question : How do visual and olfactory stimuli influence preference?



Preference of nest box 1 over nest box 2 (choice experiment to test "color preference")

Results

Question : How do visual and olfactory stimuli influence preference?

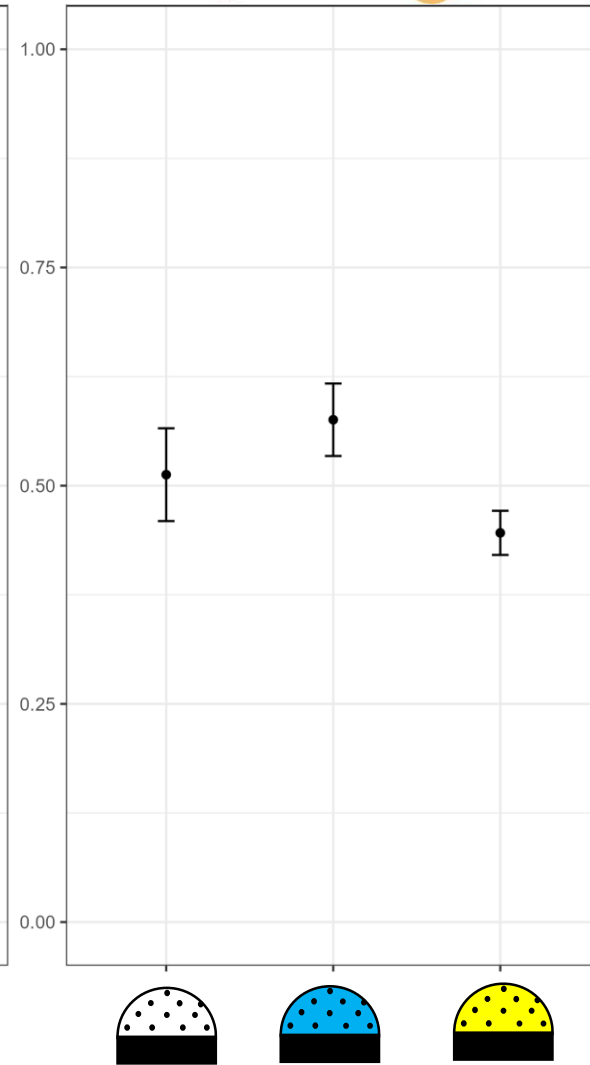
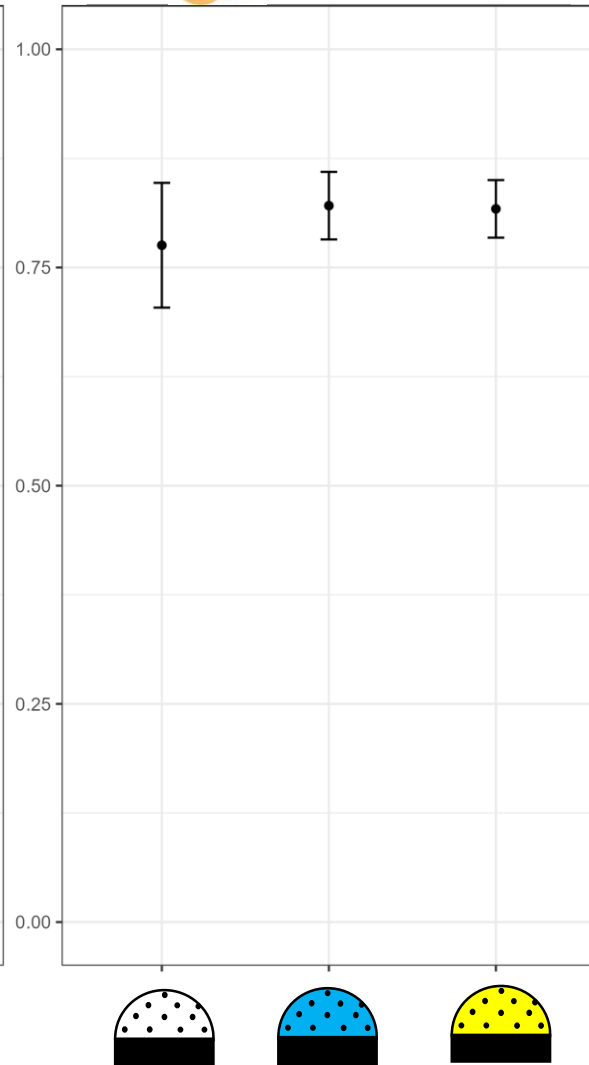
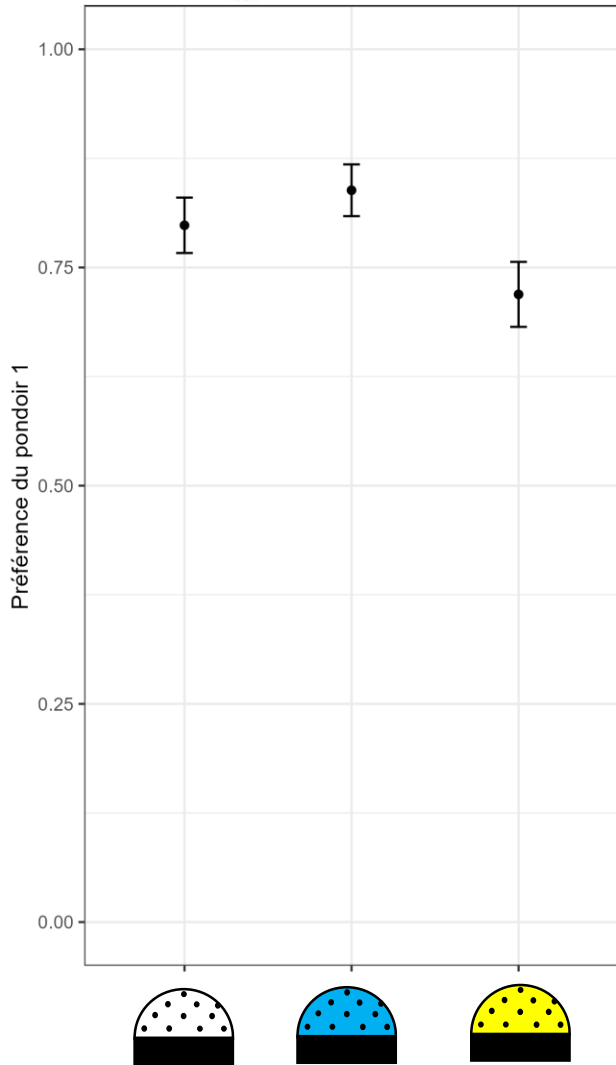
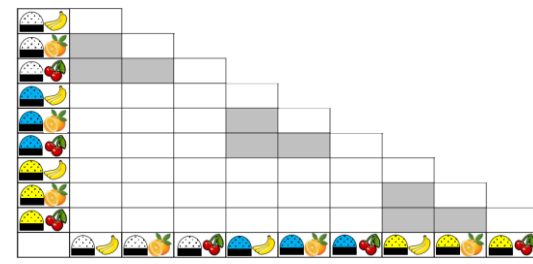


Color preference ranking :
white << yellow ≤ blue

Preference of nest box 1 over nest box 2 (choice experiment to test "color preference")

Results

Question : How do visual and olfactory stimuli influence preference?

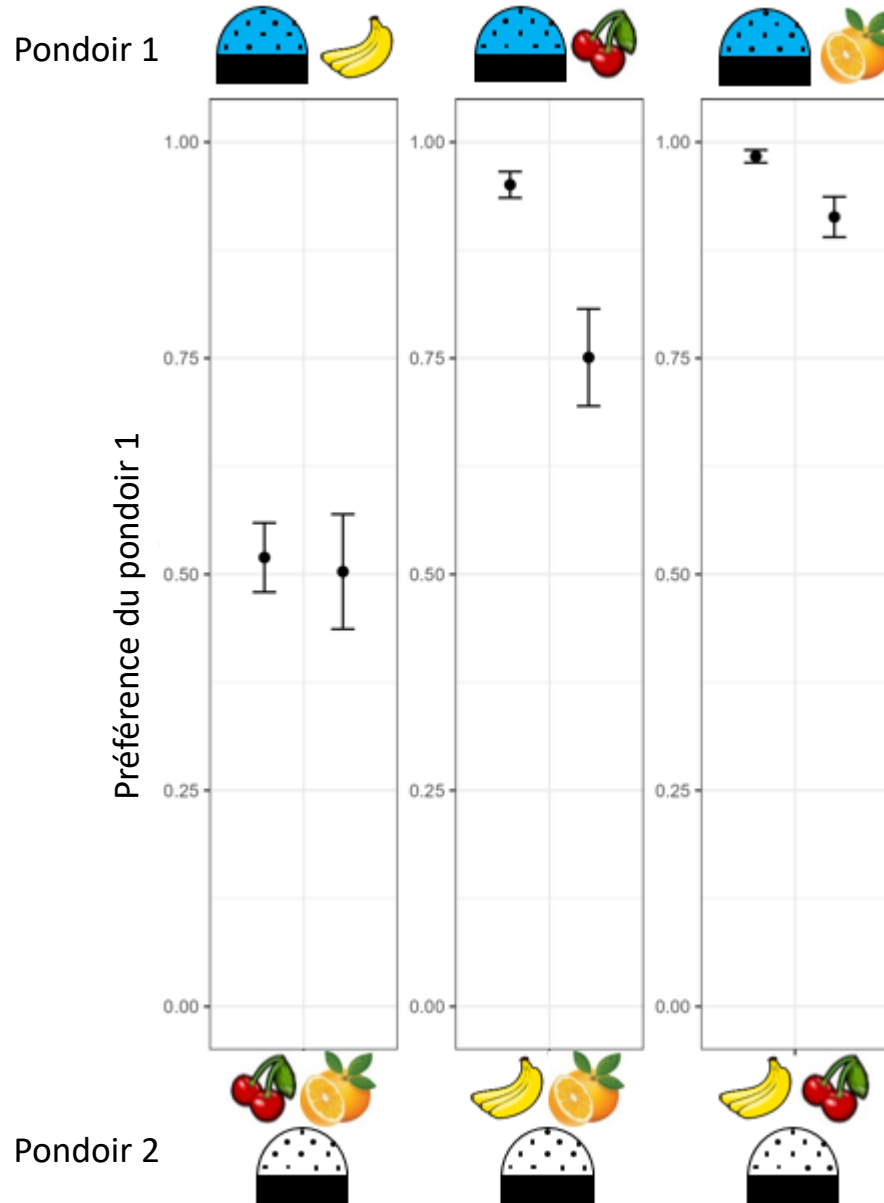
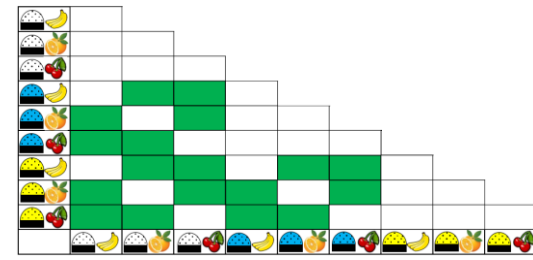


Odor preference ranking :
banana << orange ≈ cherry

Preference of nest box 1 over nest box 2 (choice experiment to test "odor preference")

Results

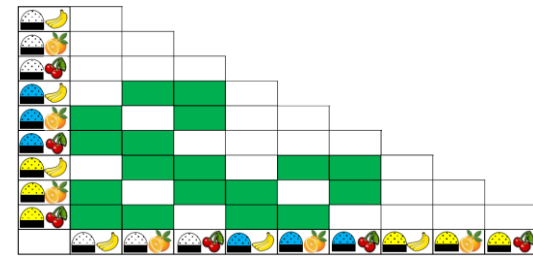
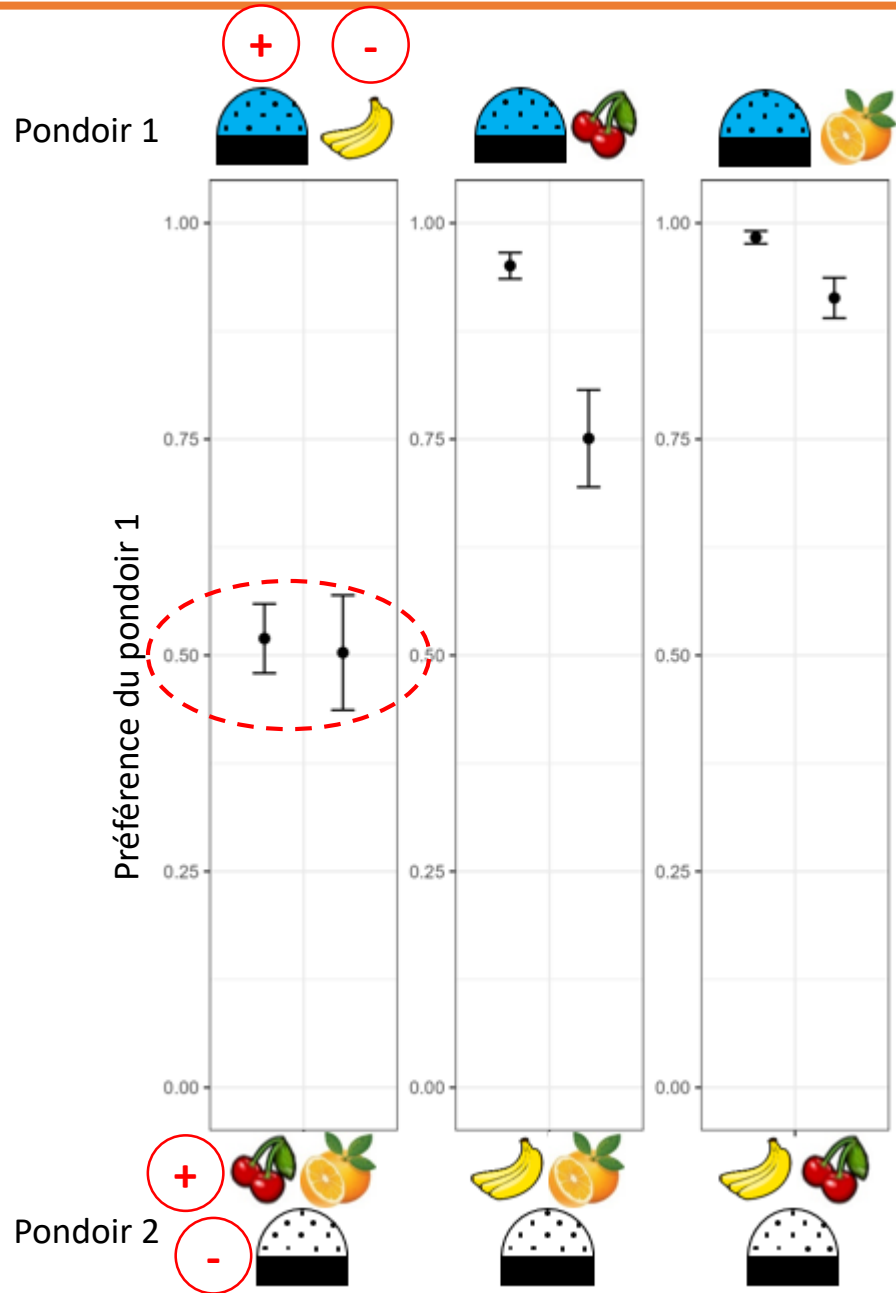
Question : How color-odor interaction influences preference ?



Preference of nest box 1 over nest box 2 (choice experiment to test "color-odor interaction")

Results

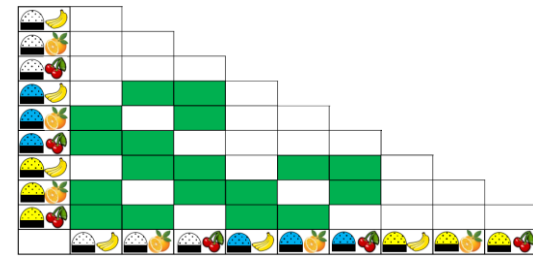
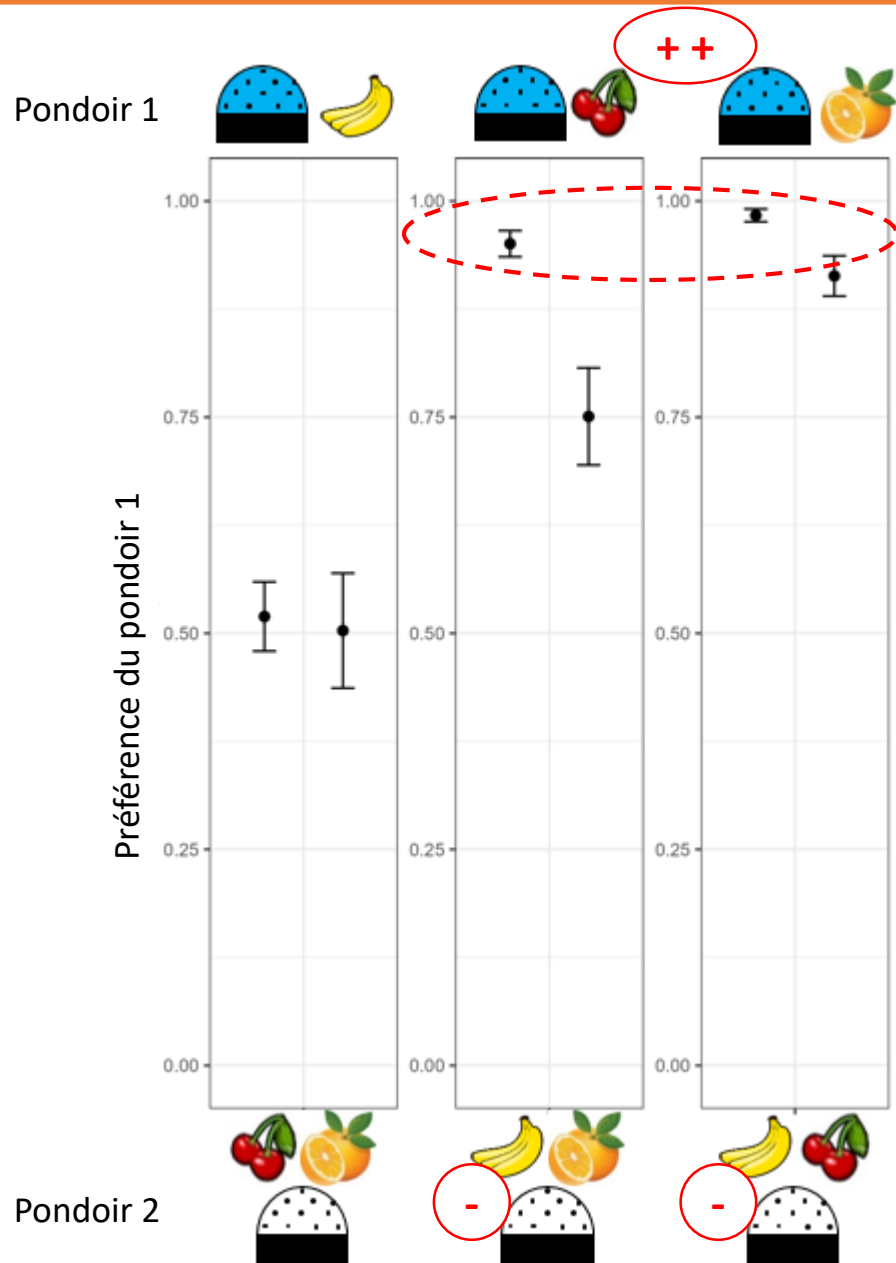
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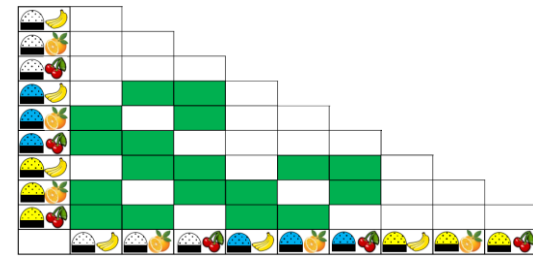
Preference of nest box 1 over nest box 2 (choice experiment to test "color-odor interaction")

Results

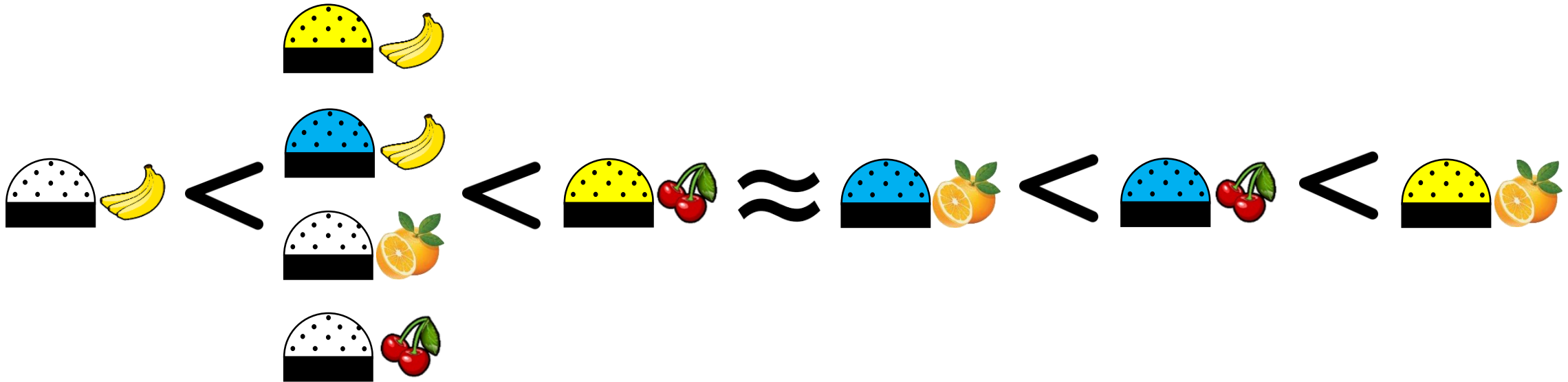
Question : How color-odor interaction influences preference ?



Preference of nest box 1 over nest box 2 (choice experiment to test "color-odor interaction")



Color*odor preference ranking





Impact of visual AND olfactory stimuli on :

- Number of eggs
- Choice of laying site (preference)

Acceptance \approx preference

- Increased contrasts in choice experiences

Color * odor = interaction

- Preference more or less easy to predict
- Depending on color and odor, the female's attraction is different

Impact of visual AND olfactory stimuli on :

- Number of eggs
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Color * odor = interaction

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Visual AND olfactory stimuli are BOTH important for pest control



Objectives

- Study the different sources of phenotypic plasticity and their effects on egg-laying preference
- Study the role of phenotypic plasticity on the dynamics of adaptive evolution during a (controlled) change in female preference



Thesis supervised by Benoit and Julien

Thank you for your attention
Thanks to Benoit, Bruno and Julien



Bibliographical references

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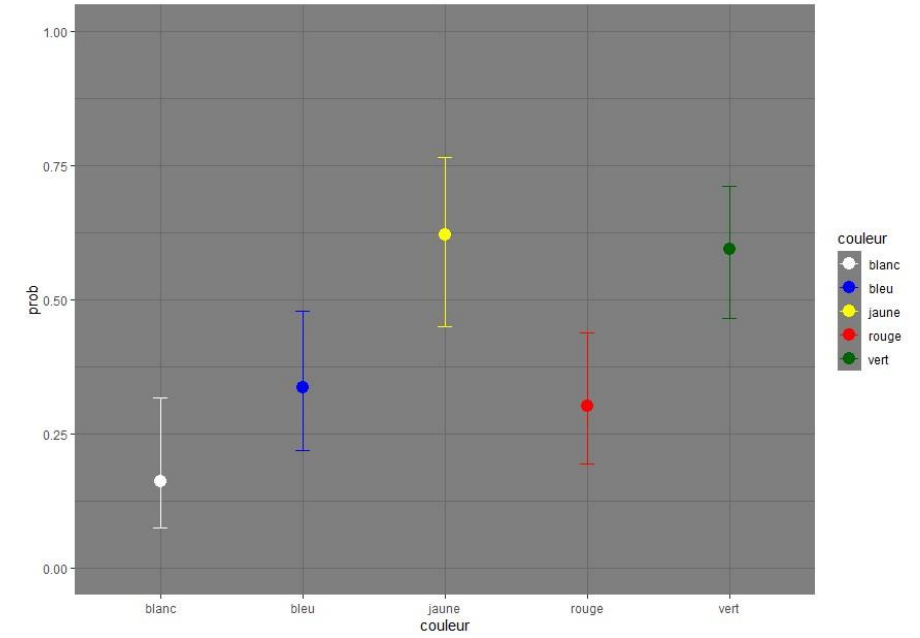
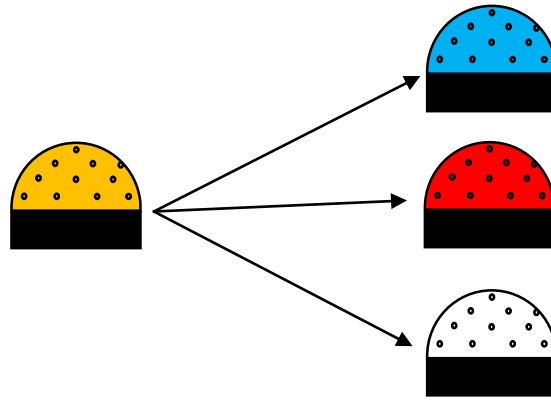
Additional slides



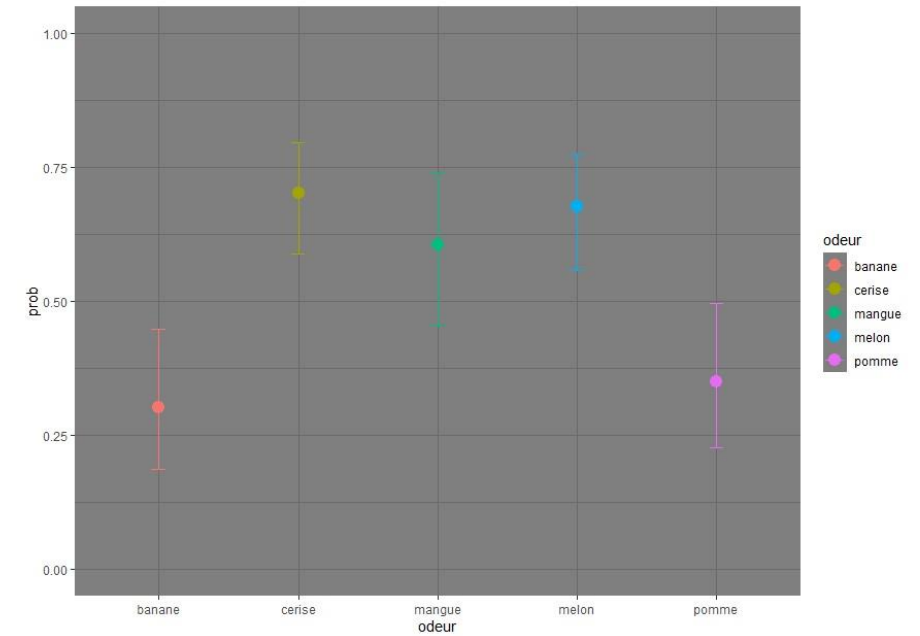
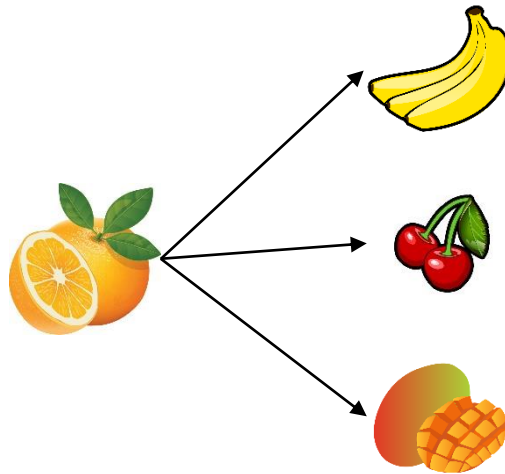
Cera Trap est un appât liquide composé de protéines hydrolysées par voie enzymatique, sans insecticides, qui libère une série de composés volatils, principalement des amines et des acides organiques. La mouche méditerranéenne des fruits (medfly) est fortement attirée, pénètre dans les pièges appâtés avec la protéine hydrolysée et, ne pouvant s'échapper, se noie dans le liquide et meurt. **(Sierras *et al.*, 2016)**

Preliminary results

Color preference tests (without odor)

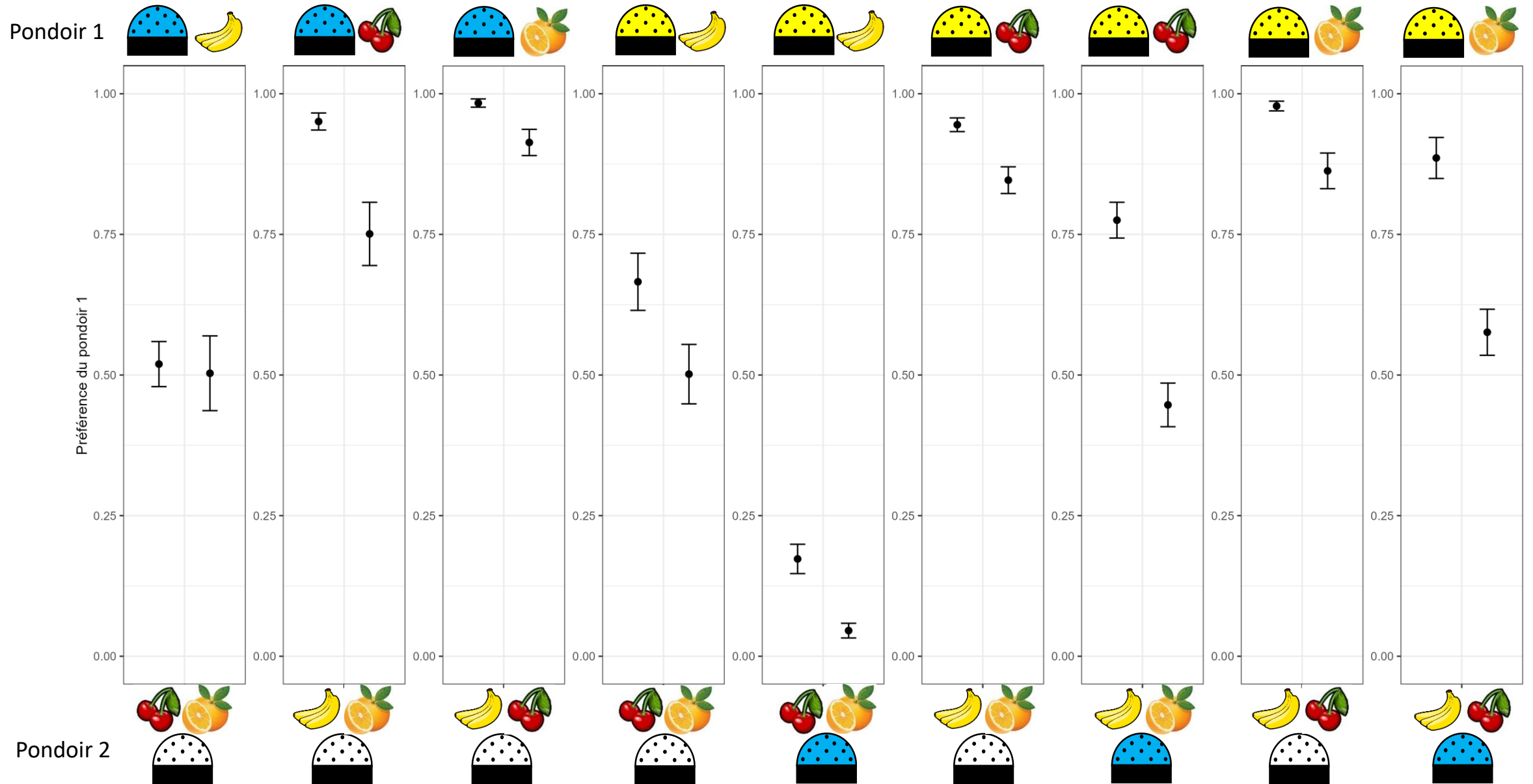


Odor preference tests



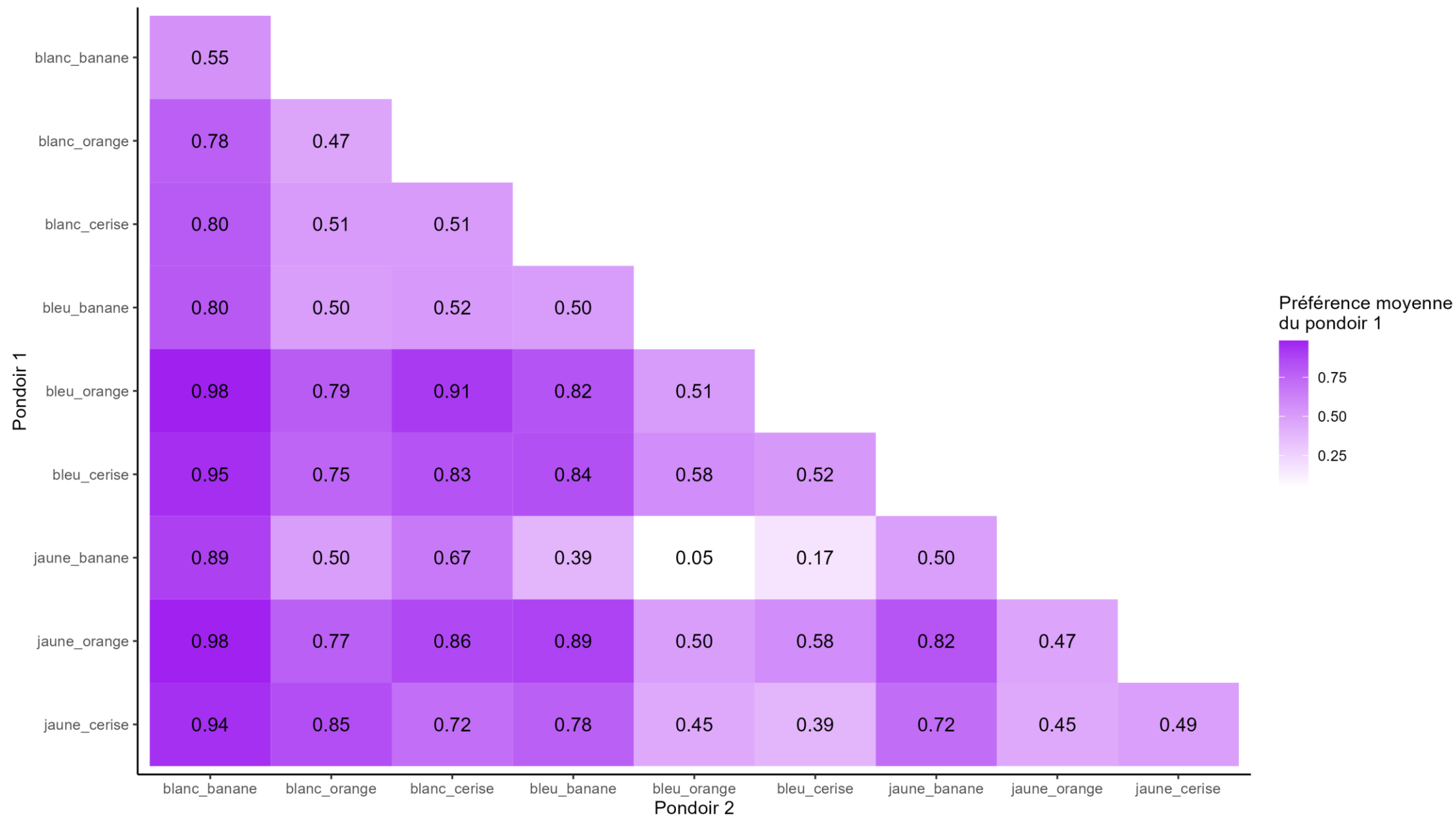
Results

Preference of nest box 1 over nest box 2 (choice experiment to test "color-odor interaction ")



Results

Préférence observée du pondoir 1 par rapport au pondoir 2



Results

Préférence attendue du pondoir 1 par rapport au pondoir 2

