

Nasonia vitripennis and nasonia giraulti memory analysis



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1 Introduction

Learning and memory are similar traits across the Animal Kingdom, at the behavioural as well as the cellular level (Dubnau, 2003). The *Nasonia* genus is a good model to study memory for several reasons. Indeed, these insects reproduce rapidly and easily so it is possible to have a lot of them in a short time, therefore a lot experiments were conducted. They are more precisely parasitoids wasps, which means they kill and consumes their host for development (Lafferty & Kuris, 2002). Parasitoids are not able to reproduce without hosts (here, various fly pupae) causing a selection pressure on all traits connected to successful host location, including learning behaviour and memory structure (Schurmann, et al., 2009). Nevertheless, ecological differences among genus permit to compare species. *Nasonia* is a small <https://assignbuster.com/nasonia-vitripennis-and-nasonia-giraulti-memory-analysis/>

hymenoptera from the *Pteromalidae* family (approximately 2mm in length).

It is commonly referred as the 'jewel wasp' because of their iridescent coloration when observed under microscope (Werren & Loehlin, 2009). Four species has been found in this genus but this study only talk about *Nasonia vitripennis* and *Nasonia giraulti*. These two species present some ecological differences that influence their learning strategy and retention memory.

During an associative learning experience, an insect will associate a specific cue with a rewarding or punishment stimulus. As a result, the insect will show an increased or decreased preference toward that cue (Katja M Hoedjes & Smid, 2014). A reliable cue will facilitate the formation of long-term memory whereas a non-reliable cue will be only remembered few hours (short-term memory). This kind of experience can optimize foraging and reproduction behaviour (Laverty & Plowright, 1988).

Memory formation can be classified in different phases: short-term memory (STM) is first formed followed by mid-term memory (MTM) and then two forms of long lasting memory which are long-term memory (LTM) and anaesthesia-resistant memory (ARM). Reliable information can provoke the formation of long-lasting memory whereas information judged not reliable will be classed in short-term memory, which is disrupted by amnesia after few hours; therefore, it prevent an animal from storage of information unless it was proven to be reliable (Smid et al., 2007).

2 *Nasonia* genus: presentation

2.1 Generality on *Nasonia* genus

There is a lot of parasitoid wasps (approximately 150000 species), this group represent a large population of insect that have the capacity to lay their
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eggs in or onto other insects called hosts, which will eventually die with the development of the parasite larvae (Lafferty & Kuris, 2002). These wasps parasite several fly pupae. *Nasonia* is a small hymenoptera from the Pteromalidae family. Males of *Nasonia* genus are haploids but females are diploids, therefore, a female with non-fecundated eggs can give birth but only to a male population (Werren & Loehlin, 2009). After the oviposition (i. e. to lay eggs with an ovipositor), the fly life-cycle is interrupted because of the venom injected to the host when eggs are laid (Ratcliffe & King, 2009). The *Nasonia* larvae feed on the host until they become adult. When the adult stage is reached, *Nasonia* will emerge to find new hosts to parasite. Finding a new pupa is not an easy task to accomplish because hosts remain inconspicuous. However, they have the capacity to resolve this problem by using indirect, chemical information as odours of various substrates (e. g. decaying mushrooms, carcasses, odours of various plants) that permit to locate habitat of hosts (Katja M Hoedjes et al., 2011). These insects have innate preferences for some stimuli which help them to find a suitable host; however, oviposition experiences can modify these preferences (Smid et al., 2007). Indeed, host is perceived as a reward and is associated with stimuli (as odours) present in the host habitat; therefore, this capacity is used to study learning and memory dynamics among these wasps (Hoedjes et al., 2012). Four species has been discovered in the *Nasonia* genus in different part of the world called *N. vitripennis* , *N. giraulti* , *N. longicornis* and the newest one *N. oneida* (Desjardins et al., 2010). *N. giraulti* is distributed in the east of North America and *N. longicornis* in western North America. *N. longicornis* and *N. giraulti* are parasitoids of *Protocalliphora* fly pupae that can be found in bird nests. *N. vitripennis* is distributed in the entire world and <https://assignbuster.com/nasonia-vitripennis-and-nasonia-giraulti-memory-analysis/>

parasitizes diverse fly pupae that are found on carcasses and in bird nests (Gadau et al., 2008). These species differ in host range and host preferences (Darling & Werren, 1990). The life cycle of *Nasonia* is similar to that of other parasitoids. All three *Nasonia* species sting and lay their eggs upon the pupae of flies, specifically blowflies, flesh flies, and houseflies.

2. 2 Ecological and physiological differences between *N. vitripennis* and *N. giraulti*

On a first hand, *Nasonia vitripennis* is a generalist parasitoid that uses diverse hosts of calyptrate flies including blowflies, house flies and flesh flies (Desjardins, et al., 2010). Its distribution is holarctic. *N. vitripennis* is gregarious which means it can lay several eggs into one host.

On the other hand , *Nasonia giraulti* is a specialist, it parasitizes in *Protocalliphora* (bird blowflies) (Desjardins et al., 2010). It is distributed mostly in the north-eastern part of North America. *N. giraulti* is solitary, therefore, female will lay only one egg per host and that infected hosts are far from each other.

Males of *N. vitripennis* have small wings and are not able to fly, whereas males of *N. giraulti* have large wings similar in size to those of females, and it can fly, even though this capacity is better in female wasps (Werren & Loehlin, 2009). Werren and Loehlin (2009) also show that, as the consequence, males will stay near the pupa to protect adult females that have not emerged yet and mate within the natal patch.

3 Formation and retention memory among parasitic wasps

3.1 Different types of memory

After a learning experience, various types of memory which have different particularities and cellular pathways can be formed (Hoedjes & Smid, 2014).

The first type of memory is formed just after a learning experience; it is called short term memory (STM). It lasts minutes to a few hours (van den Berg et al., 2011). STM is also called anaesthesia-sensitive memory (ASM) because it can be disrupted by anaesthesia (Xia, et al., 1998). It was suggested that short term memory was used for discriminating against hosts already parasitized, and therefore avoid self-superparasitism (Ueno & Tanaka, 1996). Indeed, the same research suggested females would use smell to remember and discriminate against self-parasitized hosts by matching the odours on it with the odour memorized from hosts *Nasonia* has already parasitized. Then memory will consolidate to form something called the intermediate memory or mid-term memory (MTM). This phase of memory start after 24h and can lasts up to 96h, it would be an important adaptive phase to avoid costs due to formation and maintenance of memory for non-reliable host-patch-associated cues (Schurmann et al., 2009). The following memory types are long-lasting memory, two mains types of consolidation can be observed: anaesthesia-resistant memory (ARM) and long-term memory (LTM). LTM is the most stable and durable type of memory and requires protein synthesis, in contrast to ARM, which is resistant to anaesthesia but does not require protein synthesis (Smid et al., 2007).

Generally, single or massed conditioning trials, i. e. without or with a short inter-trial interval, will result in the formation of ASM and ARM. Many animal species will only form LTM after spaced conditioning, i. e. multiple trials with <https://assignbuster.com/nasonia-vitripennis-and-nasonia-giraulti-memory-analysis/>

a longer inter-trial interval (e. g. Margulies et al., 2005; Eisenhardt, 2006).

There is, however, variation in the number of conditioning trials required to form LTM: some insect species will form LTM after only a single conditioning trial.

Potentially unreliable information is stored in STM or MTM but reliable information is stored in LTM (Schurmann et al., 2009).

LTM formation after a single trial has been demonstrated in a number of parasitic wasp species

4 Effects of ecological and physiological variations on retention memory

Generalists as *N. vitripennis* need to divide their attention over a large variety of cues, which reduces searching efficiency owing to a limited brain capacity for simultaneous processing of information (Dukas, 1998). This could explain why most of insects are specialists (e. g. *N. giraulti*), as they are able to focus on a more limited set of cues compared with generalists. Thus, learning could be a sort of temporal specialization (Ishii & Shimada, 2009).

Gregarious/solitary, resulting in a difference in the number and temporal distribution of foraging experiences between the two wasp species (Bleeker et al., 2006). Indeed, *N. vitripennis* will lays most of its eggs in many hosts present on only one infested host nest. The oviposition experiences occur in rapid sequences that can be associated to massed learning experiences (Smid et al., 2007). As a contrary, *N. giraulti* lays only one egg per host and has to find a new host site for each pupa it parasitizes (infest only one per <https://assignbuster.com/nasonia-vitripennis-and-nasonia-giraulti-memory-analysis/>

site). Such a sequence of host encounters constitutes a series of many, temporally spaced learning experiences.

Massed learning/ spaced learning experiences

Physiological differences : wings => does not seem to affect memory dynamics

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