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Summary of Newly Found Ants' Cognitive Abilities, and Their Occurrence in Humans

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Abstract

Authors studied the cognitive abilities of the ant *Myrmica sabuleti* Meinert 1861, and in addition to the separate publications of their findings, they also summarized them in until now three papers. Here, the authors summarize their eight last findings, and report similar abilities in humans as well as advices for acquiring and using them. The ants can associate visual cues, numbers of elements, and odors with the time periods of their occurrence, and do so taking into account the characteristics of the elements. Humans should do so for ameliorating their daily life. For adding two numbers, the ants must see them with a time gap not exceeding 8 minutes. The ants discriminate recent and previously perceived events, locating the recent but not the old ones on a 'time line'. Humans must learn to evaluate the passing time, to have a 'time line'. The ants' time perception is underestimated when they are more active. This is true for humans, and must be considered while working, playing or doing nothing (e.g., elderly persons). The ants can navigate using a learned (memorized) sequence of odors. Humans must learn sequences of cues for finding their way. The ants discriminate even and odd numbers until the number 7. Humans are sensitive to numbers' parity, and this should freely impact their choice. Shortly, the authors revealed four cognitive abilities in ants which should occur in humans, natively or acquired through experiences, at a more precise, complex and extended level, in order to provide them with an as comfortable as possible live.

Keywords: association between events and time, learning, navigation, number parity, operant conditioning, time perception

1. Introduction

1.1 General Considerations

The authors work on the behavior and the cognitive abilities (essentially their numerosity ones) of the ant *Myrmica sabuleti* Meinert, 1861. They published each of their works, and in addition, for the readers' convenience, they published summarizes of these works. Until now, they have published three summarizes (Cammaerts & Cammaerts, 2020a, b; 2022a). Having performed eight novel works since the publication of the authors' last summary, here they briefly relate, in a fourth summary, the authors' eight last findings on *M. sabuleti* workers' skills.

The materials and methods used for conducting the summarized works are described in detail in each of authors' eight publications (Cammaerts, 2023; Cammaerts & Cammaerts, 2022b, c, d, e, f; 2023; unpublished data). They are specific to each work, and are here only very briefly recalled. The obtained results are reported with no omission, but without details, comments and expected future researches. The here presented tables are new never published ones. In the same way, the here shown figures are new never published before.

As for the introduction of each of the eight summarized works, the authors below report only what is essential for understanding why they did these works and what is known on the subject, and they refer the readers to find more information in their previous publications (see the references here above).

On the contrary, due to the topic of the present edited journal, the authors enlarged comments on what occurs, causes problems, is known and studied in humans for the different subjects and abilities successively examined.

1.2 Introduction to Here Summarized Works

1.2.1 Association of Experienced Events With Their Time Period Of Occurrence

Associating experienced events with the time period of theirs' occurrence is an ability detained by humans, as well as by evolved animals (e.g., cats, dogs, birds ….). Nothing having yet been investigated as for the existence of this ability in insects, and knowing that ants detained many behavioral capabilities, authors examined if the workers of the ant *M. sabuleti* could associate visual elements, numbers of elements, and odors with the time period during which they were perceived. Such an association is plausible because, during a conditioning or learning, the individuals memorize not only the required stimulus or information but also several environmental prevailing parameters such as the location, other occurring events, and above all the current time (Cooper, 1991; Molet & Miller, 2014; Enquist, Lind & Ghirlanda, 2016; Chaudran & Thorwart, 2021; Savastan & Miller, 1998). Doing so is favorable to a comfortable live (see the Discussion section).

Coming back to *M. sabuleti* workers, it was shown that these ants do not take into account the characteristics of the elements when they simply count these elements, but take these characteristics into account when they add the elements (Cammaerts & Cammaerts, 2020c, 2021). Therefore, the authors looked if, when associating numbers with the time period of their occurrence, these ants take or do not take into account the characteristics of the perceived numbers.

1.2.2 Time Perception

Associating experienced events with theirs' time periods of occurrence requires having a notion of the running time. The workers of the ant *M. sabuleti* have such a notion (Cammaerts, 2010). How do they perceive the running time? According to which rule, which function? There was no answer to these questions, and authors thus were aimed to investigate on the subject. The authors first tried to define the maximum time gap between the perception of two numbers for the ants still adding them, what provide some idea about the ants' time perception, i.e., their perception does not fit a linear function. After that, authors experimentally studied how the ants estimate the passing time.

Time intervals are very important in any communication systems. Information is often transmitted in the form of successive signals having a given duration and being separated by given time gaps (Fraise, 1978). Frogs communicate thanks to a series of pulses, with short time gaps between the pulses and longer time gaps between series, and the gaps are species specific (Rose, 2017). The duration of the gaps is often essential, e.g., in birds' song (Aubin & Bremond, 1983). There is no doubt that animals, such as bees, fishes, birds, mammals perceive the running time: a lot of information is given in the book of Richelle and co-authors (Richelle *et al.,* 1980), as well as in the review of Martin - Ordas (2020). Animals can even remember past events and plan for the future (Logan, 2014). They detain what is named an 'episodic-memory' (Zentall, 2005).

Zentall and co - authors observed that pigeons underestimated the passing time when they had to peck (Zentall *et al*, 2006). In the same way, humans overestimate the passing time when they do nothing. Authors were interested to know if such a change of time estimation due to the individuals' activity could exist in ants.

1.2.3 Learning and Use of a Sequence of Odors for Navigating.

The workers of the ant *M. sabuleti* use essentially odors for navigating (Cammarts & Rachidi, 2009). They can associate perceived odors with the time period of this perception (Cammaerts & Cammaerts, 2022d). However, for navigating in nature, it should be useful to recognize and use a few odors. Therefore, authors examined if these workers can learn a sequence of odors and use it to travel between their nest and their food site.

Ants forage using their pheromones markings, visual landmarks, a sequence of visual cues (Wehner, 2003), cues located in the canopy (Salo, 1998), celestial cues (Wehner, 1997), path integration (Macquart & Beugnon, 2007), odometry (Wittinger *et al.*, 2006), and odors (Steck *et al.*, 2009, 2011). The latter strategy is the less until now studied. Authors' investigation on *M. sabuleti* workers' potential learning and use of a sequence of odors could thus bring new information on the subject.

1.2.4 Parity Sensitivity

Humans can discriminate even and odd numbers (more information on this ability is given in the discussion section), and this skill was recently found in bees (Bernard *et al.*, 2006). The authors were thus aimed to examine if ants can also be sensitive to the parity of the numbers, conditioning them to an even *versus* an odd number, or to an odd *versus* an even number, and testing then them in front of other even and odd numbers having the same total area and being somewhat otherwise located. Number parity sensitivity having not yet investigated in animals, such an aim 'opened a new door'.

2. Materials and Methods

2.1 Collection and Maintenance of Ants

The ants were collected in spring 2022, in Ardenne (Belgium) from an abandoned quarry. The ant colonies nested under stones and in grass, and contained about 500 to 1,000 workers, 1 to 3 queens and brood. In the laboratory, they were kept in 1 to 3 glass tubes half filled with water, a cotton plug separating the water from the part devoted to the ants' nesting. The nest tubes of each colony were set in a tray the borders of which having been covered with talc. These trays served as foraging areas: food was there delivered (larvae of *Tenebrio molitor* three times per week; sugar water permanently delivered in a small plugged tube), and the ants' training was also conducted in these trays. The lighting varied between 330 and 110 lux, the humidity always equaled 80%, the temperature constantly equaled 20°.

2.2 Training and Testing the Ants

The cues presented to the ants were small tubes filled with pieces of odorous plants (one study) or stands made of strong white paper and bearing dots (black or colored; circles, squares, stars etc…) (the other seven studies). In fact, the dots were drawn on white paper, inside 2 cm x 2 cm squares using Microsoft Word® software. They were then cut and tied with extra transparent sticky paper on the front face of a stand. Each stand had a vertical part (2 cm x 2 cm) bearing the drawn dots, and a horizontal one [2 x (1 cm x 0.5 cm)] which duly folded allowed its vertical maintenance (see Figures 1, 2, 3).

The ants were training in their foraging area, the cue to learn, memorized being set near the nest entrance and near the food, and the cue to not memorize being set far from any reward. The ants were tested in a separated tray in front of two to three cues including that they should memorize, or in a Y-maze during the study of the ants' time perception (Figure 1). The cues used to test the ants were similar to those used to train them, but were novel, never used. The precise experimental design and procedure somewhat differed between the eight conducted studies according to the aim, the topic of each of these studies.

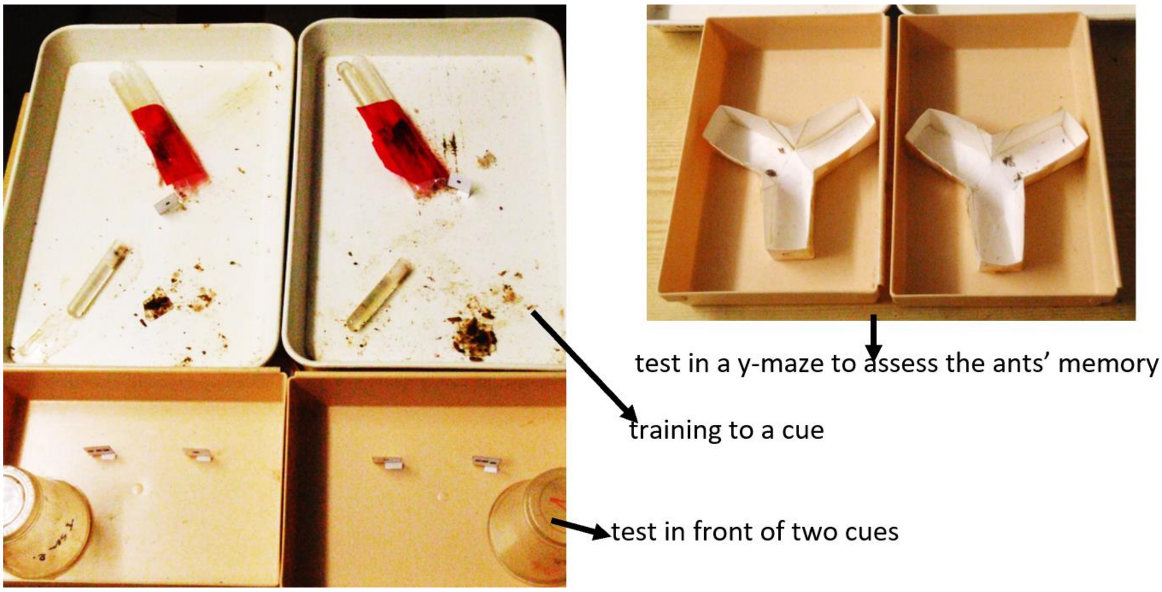

Figure 1. Experimental design used to train and test the ants for examining skills they may detain, and briefly related in this paper. The design of each experiment somewhat differed according to the skill examined, and each design is schematically drawn in each of the eight corresponding publications (see Cammaerts, 2023; Cammaerts & Cammaerts, 2022b, c, d, e, f; 2023; unpublished data).

2.3 Analysis of the Results

According to the performed experiments, the results were reported as numbers of counted ants, proportions of correct responses, conditioning scores, sums or means, and seldom ratio. Each test made in the course of each experiment was submitted to a statistical analysis adapted to the recorded data (e.g., non - parametric Wilcoxon test, Chi-Square test, GLMM analysis) and what was done was each time detailed in the eight previous publications (Cammaerts, 2023; Cammaerts & Cammaerts, 2022b, c, d, e, f; 2023; unpublished data).

3. Results

3.1 Association of Cues, Numbers and Odors with Their Time Period of Occurrence, Taking into Account the Characteristics of The Presented Elements

Trained during four days to a kind of cue from 8 o'clock until 19 o'clock and to another kind of cue from 20 o'clock until 7 o'clock, the ants tested in front of these two kinds of cues responded obviously and significantly essentially at 16 o'clock to the former kind of cue, and at 4 o'clock to the latter kind of cue. They thus responded each time (at 16 and 4 o'clock) to the cue they perceived, learned, and memorized during the corresponding time period (evening + night; morning + afternoon). Authors checked that this ability did not result from some neophobia in front of a cue no longer seen during several hours, and it did not. The ants really associated perceived cues with the period of the day during which these cues were present in their foraging area. Numerical results are given in Table 1 upper (first) part, two photos in Figure 2 A, and the experimental details are in Cammaerts & Cammerts (2022b).

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In the same way, in the course of two distinct experiments, trained during four days to a number (3 or 2) of dots (rectangle or circle) from 8 o'clock until 19 o'clock and to another number (1 or 4) of the same dot (rectangle or circle), the ants tested (four times) in front of these two numbers of dots responded far more to the former number at 16 o'clock, and to the latter number at 4 o'clock. Thanks to some slight differences between the two conducted experiments, impacts of light, day and night (so, of the circadian rhythm), and dot size and shape could be excluded. The ants significantly associated a perceived number of elements with the time period of the day during which they saw this number. Numerical results can be found in Table 1, two photos in Figure 2 B, and details in Cammaerts & Cammaerts (2022c).

Table 1. Ants' association of visual cues, numbers, and odors with theirs' time period of perception, taking into account the characteristics of the perceived elements Association visual cues with time

Colonies	Testing time	During four days, n° of ants' visits to the cues presented from 8 to 19 o'clock	from 20 to 7 o'clock
A, B	16 h	360	91
	4 h	71	403
C, D	4 h	59	303
	16 h	307	79

Association numbers with time

Experiment	Testing time	During four days, n° of ants' visits to the number of dots	
		1 presented from 20 to 7 h	3 presented from 8 to 19 h
I	4 o'clock	440	42
	16 o'clock	52	319
		2 presented from 8 to 19 h	4 presented from 20 to 7 h
II	16 o'clock	331	58
	4 o'clock	33	352

Association odors with time

Colonies	odors	During four days, n° of ants' visits to the odor perceived
Testing time		

A, B thyme lavender	from 20 to 7 o'clock	from 8 to 19 o'clock
4 o'clock	411	51
16 o'clock	89	405
C, D rosemary, orange zest	from 8 to 19 o'clock	from 20 to 7 o'clock
16 o'clock	371	79
4 o'clock	41	406

Taking account of the elements' characteristics

Experiment, colonies, n° of dots change, testing time		N° of ants' visits to 1, 2, 3 dots seen from 8 to 19 o'clock and to 3, 4, 5 dots seen from 20 to 7 o'clock, the size, color or shape of the dots being or not being changed
I A, B 1 *vs* 3		
different size	16 o'clock	110 and 107
(3 days)	4 o'clock	118 and 114
no difference	16 o'clock	55 and 17
(1 day)	4 o'clock	14 and 61
II C, D 2 *vs* 4		
different color	16 o'clock	114 and 111
(3 days)	4 o'clock	107 and 91
no difference	16 o'clock	111 and 14
(1 day)	4 o'clock	8 and 71
III E, F 3 *vs* 5		
different shape	16 o'clock	147 and 144
(3 days)	4 o'clock	105 and 98
no difference	16 o'clock	96 and 19
(1 day)	4 o'clock	17 and 83

Every result was statistically studied and found significant. More details are reported in the papers relative to this topic (Cammaerts, 2023; Cammaerts & Cammaerts, 2022b, c, d).

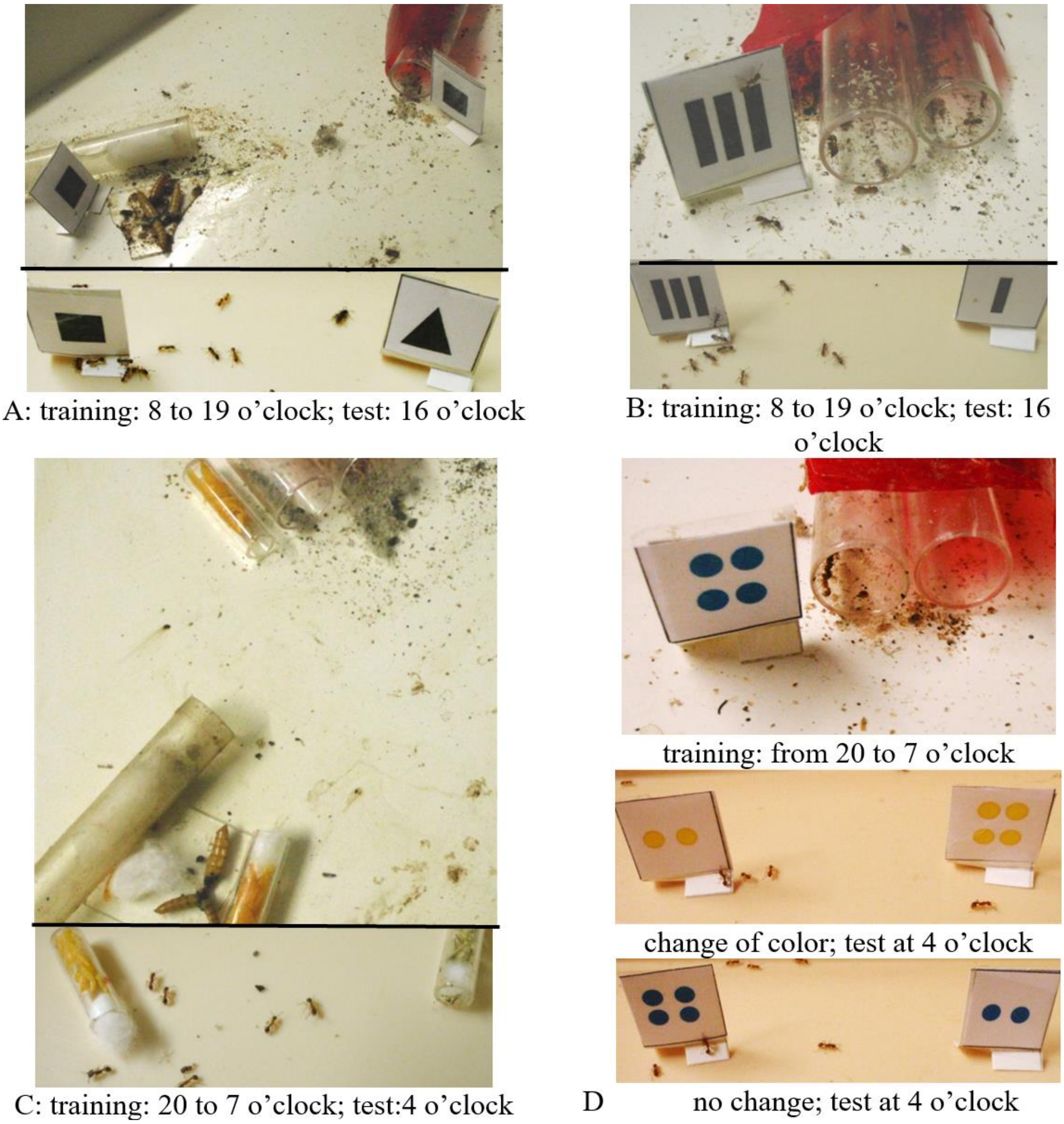

Figure 2. Association of cues (A), numbers (B) and odors (C) with their time period of occurrence, taking account of the elements characteristics (D). The ants responded essentially to the elements presented during the corresponding time period of these elements' perception, except when a characteristic of these elements was changed (here illustrated: the color, photos D). A summary of the numerical results is given in Table 1.

Then, two experiments were made, each one on two colonies, training the ants to an odor (thyme or orange zest) from 20 to 7 o'clock, and to another odor (lavender or rosemary) from 8 to 19 o'clock during four days. Note that the kind of odor (pleasantly aromatic or powerfully vegetal) differed between the two conducted experiments. During these four days, the ants were tested four times (n° of tests = 4 x 2) in front of the two used odors once at 4 o'clock and a second time at 16 o'clock, and each time, they essentially responded to the thyme or orange zest at the former time o'clock, and to the lavender or rosemary odor at the latter time o'clock. They thus responded each time to the odor they perceived during the corresponding time period of the day, i.e., they associated the odors with the time period during which they perceived them. The summarized numerical results are given in Table 1 third part, two photos are shown in Figure 2 C, and details can be found in Cammaerts & Cammaerts (2022d).

A last experiment was performed on three pairs of colonies, training the ants of each pair using a different kind of dot (black square, blue circle, black triangle) and two different numbers of these dots (1 and 3, 2 and 4, 3 and 5), the smaller number being presented from 8 to 19 o'clock, the larger one from 20 to 7 o'clock. During this training, the ants were tested each day at 16 and 4 o'clock in front of the two numbers of dots presented during training, but with a characteristic of these dots being modified (the size for the square, the color for the circle, and the shape for the triangle). During each of the six tests conducted on each pair of colonies, the ants visited nearly equally the two presented numbers of dots, having thus not associated each number of dots with the time period of the day during which they saw them. This means that when associating perceived elements with the time period of their occurrence, the ants take into account the characteristics of these elements. For each used pair of colonies, after having made the six tests, the ants were tested in front of the two numbers of dots which were this time exactly the same as those received during training (same size, color or shape). During these tests, the ants significantly responded more to the smaller number of dots at 16 o'clock and to the larger number of dots at 4 o'clock, having thus this time associated what they perceived with the time period during which they experienced this perception. Numerical results are in Table 1, lower part, two photos in Figure 2 D, and details in Cammaerts (2023).

3.2 Time Perception

Since associating the perception of elements with the time period of this perception requires having a notion of the passing time, and since the workers of the ant *M. sabuleti* add numbers of dots only if seeing them simultaneously with a maximum horizontal distance of 5 cm and a maximum vertical distance of 4 cm between the two numbers (previous summaries), authors wondered what could be the maximum time gap between the perception of two numbers for still adding them. In the course of six experiments, authors presented to ants a first number of dots (1 or 2), then after a gap of 5, 10, 6, 7, 8, or 9 minutes, a second number of dots (1, or 2), and tested the ants in front of the two presented numbers and of their sum (i.e., 1 + 1, 1 + 2, 2 + 2), all this twice, on two different colonies with two different kinds of dots. The ants essentially responded to the sum of the numbers when the time gap between their presentation equaled 5, 6, 7 minutes, and to each two numbers when this gap equaled 10, 9 or 8 minutes. A graphical representation of the results allowed defining that the maximum time interval between the perceptions of two numbers for still adding them equals 7' 45''. This is illustrated in Figure 3, and detailed in Cammaerts & Cammaerts (2022e).

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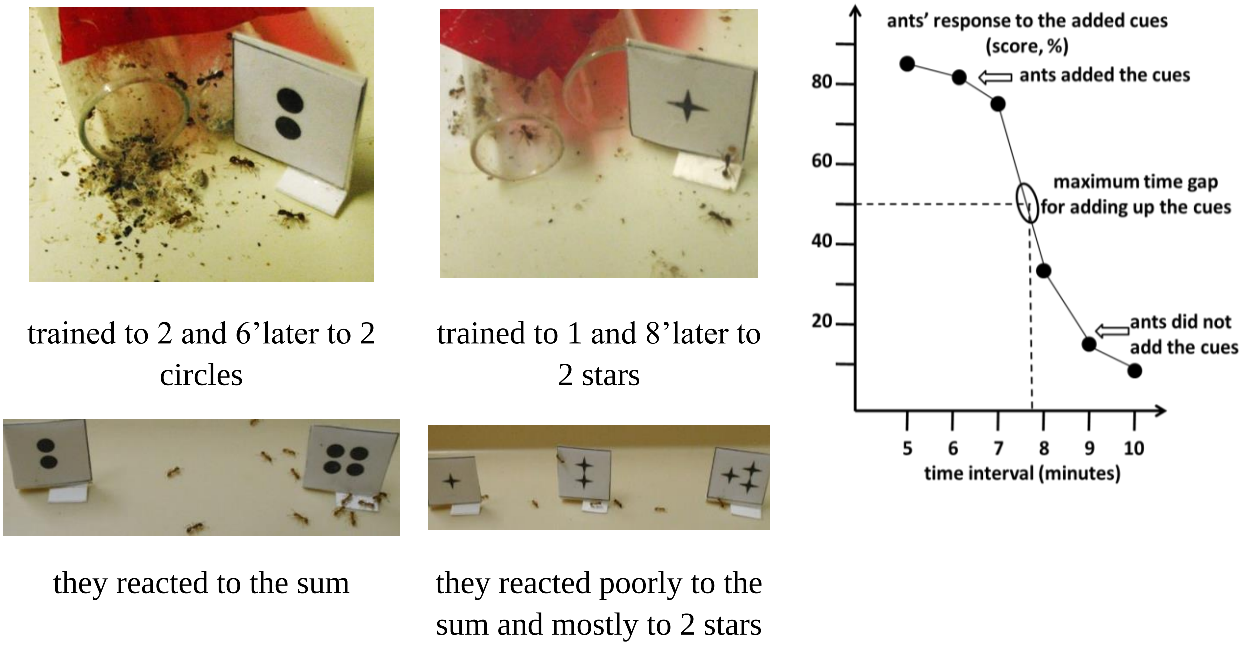

Figure 3. Maximum time gap between the perceptions of two numbers for still adding them. The gap was found to equal 7'45''. Details are given in Cammaerts & Cammaerts (2022e)

The following step was to discover how these ants perceive the passing time. The results are partly illustrated in Figure 4, and detailed in Cammaerts & Cammaerts (2022f). The authors made five experiments on four colonies using either visual or olfactory cues (the conditional stimuli) and found that after conditioning acquisition and then removal of the cues, the ants firstly kept their conditioning for a few hours, secondly lost it over time according to a sigmoid curve (during 20 – 24 hours), and thirdly brutally (from 20 -24 to 28 - 32 hours after the cues removal) no longer valuably reacted to the cues (the conditional stimuli). Later, from 30 - 40 to 60 hours after the cue's removal, the ants' conditioning score slightly again increased. Consequently, the ants distinguish recent and old events, precisely locating in time the former events, but not doing so for events occurred since more than about 28 - 30 hours. However, they keep some memory of these 'old' events, and may use this information in the future. Authors then performed other similar experiments, but increasing the ants' activity thanks to a bridge set at the nest entrance and a farther location of the food. The ants then underestimated the passing time, acting during 40 lived (perceived) hours as during the actually passing 24 - 28 hours.

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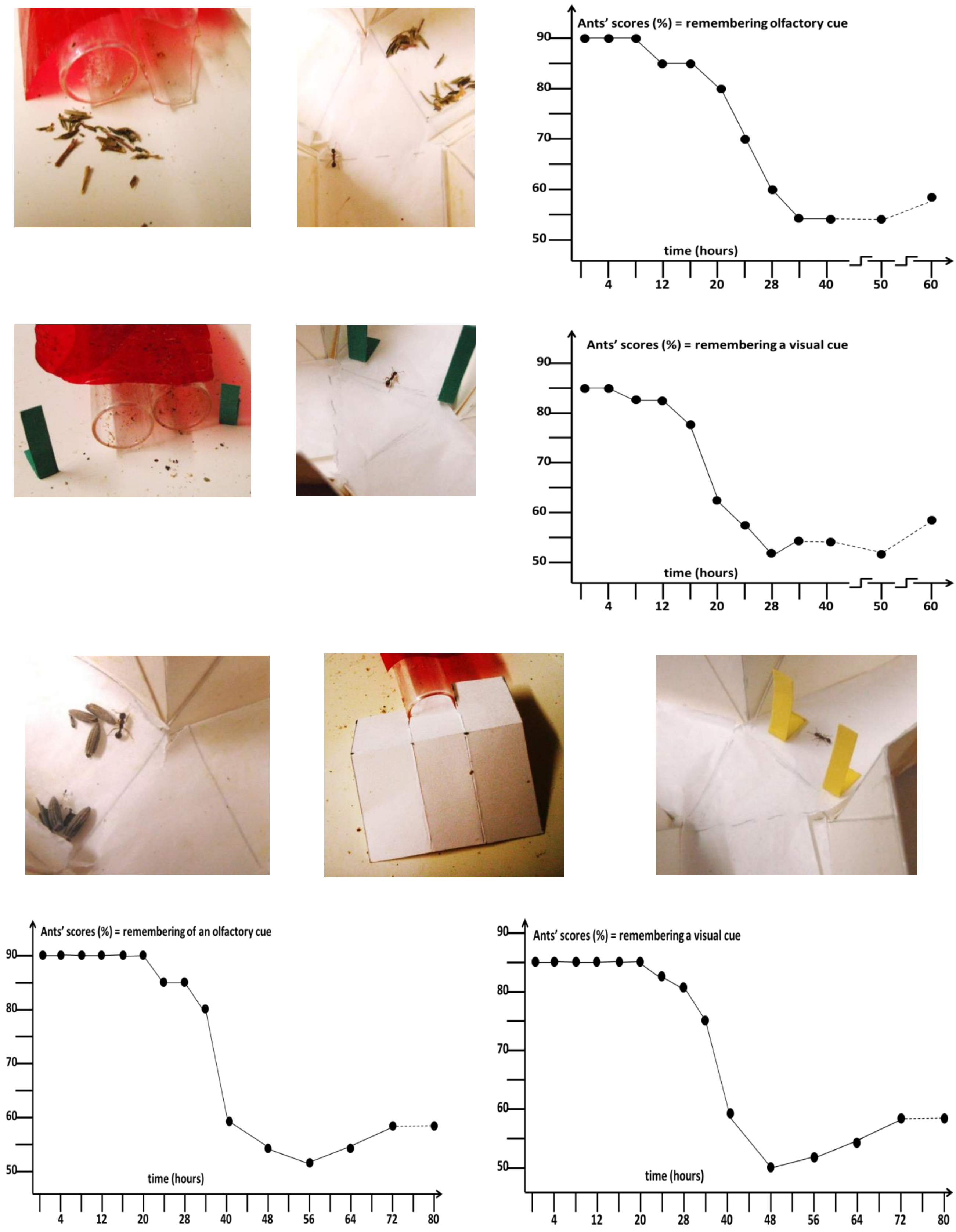

Figure 4. Ants' time perception

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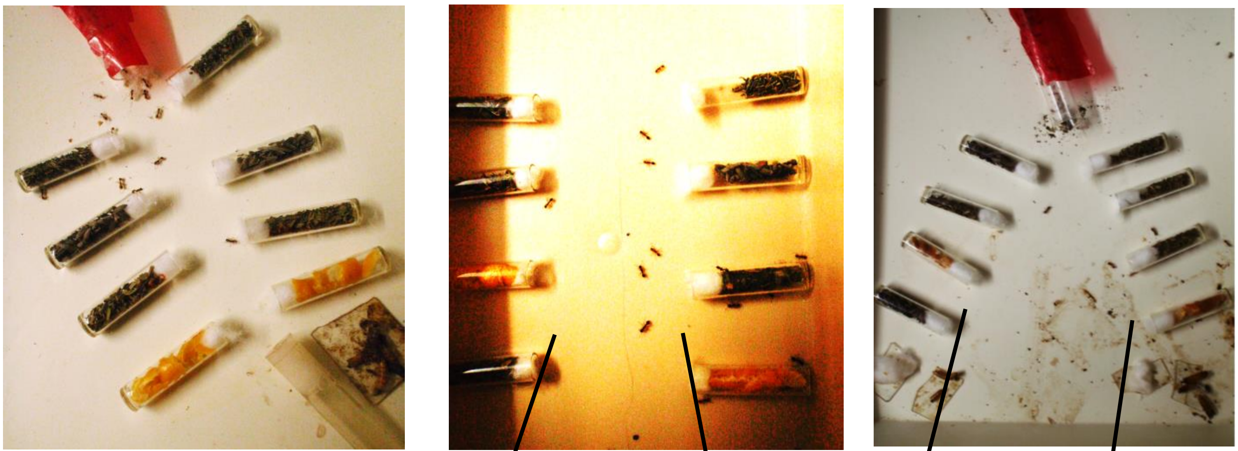
Upper part: thanks to their loss of conditioning, it was shown that the ants distinguish recent and passed (since more than 15 - 20 hours) experienced events, however keeping some memory of the latter.

Lower part: when increasing their activity, the ants underestimated the passing time (15 - 20 hours perceived though equaling ± 33 hours). Details can be found in Cammaerts & Cammaerts (2022f).

3.3 Learning and Use of a Sequence of Odors for Navigating

The ants of two colonies were trained during three days to a sequence of four odors, thyme, lavender, basilica, orange zest, deposited between the nest entrance and the food site. Then, while being still trained, the ants were tested in a separate tray once at each of the three following days faced to two sequences of odors, that used for training (the correct sequence) and anther one (f.i., basilica, orange zest, thyme, lavender) (the ‘wrong sequence’). They significantly walked essentially along the ‘correct’ sequence, having thus memorized it. After that, in the ants’ foraging area, the food site was divided into two ones, one located on the left and the other on the right of the tray, and two sequences of four odors were deposited, a ‘correct’ one between the nest and one new food site, a ‘wrong’ one between the nest and the other new food site. The ants were observed and counted: they duly followed the ‘correct’ sequence. These results are illustrated in Figure 4 and details can be found in Cammaerts & Cammaerts (2023).



training for 3 days

3 tests; total n° of sighted ants along the sequences
wrong: 381 and correct: 1.676

1 test; to travel, n° of ants using of the sequences
wrong: 5 and correct: 135

Figure 5. Ants’ learning and use of a sequence of odors. The two left photos: the ants responded to the sequence they should learn. Right photo: they used it to travel between the nest and the food. See details in Cammaerts & Cammaerts (2023)

Table 2. Ants' sensitivity to the numbers' parity

Colonies A, B trained to the even 2 *vs* 5		Colonies C, D trained to the odd 3 *vs* 4	
facing numbers; n° of tests	n° of ants seen in front of the even *vs* odd number	facing numbers; n° of tests	n° of ants seen in front of the odd *vs* even number
2 *vs* 5 ; 6 tests	378 *vs* 68	3 *vs* 4 ; 6 tests	465 *vs* 44
4 *vs* 3 ; 3 tests	153 *vs* 38	5 *vs* 6 ; 3 tests	224 *vs* 46
2 *vs* 3 ; 3 tests	221 *vs* 17	3 *vs* 6 ; 3 tests	211 *vs* 23
4 *vs* 5 ; 3 tests	249 *vs* 20	7 *vs* 4 ; 3 tests	237 *vs* 26
6 *vs* 5 ; 3 tests	187 *vs* 39	5 *vs* 4 ; 3 tests	297 *vs* 36
8 *vs* 7 ; 3 tests	118 *vs* 145	7 *vs* 8 ; 3 tests	124 *vs*89
6 *vs* 7 ; 3 tests	207 *vs* 49	7 *vs* 6 ; 3 tests	225 *vs* 46
2 *vs* 1 ; 3 tests	281 *vs* 33	1 *vs* 2 ; 3 tests	218 *vs* 18

Above the black line: conditioned ants correctly responded to the even (A, B) or odd (C, D) number, whatever the presented numbers, perceiving thus the parity of the numbers.

Below the black line: this sensitivity is efficient from the start of the numerosity (the ants discriminated the parity of the numbers 1, 2) until the number 7 (they discriminated the parity of 6 and 7, poorly that of 7 *vs* 6, no longer that of 8 *vs* 7). This is partly illustrated in Figure 6, and will be detailed in Cammaerts & Cammaerts (unpublished data).

3.4 Parity Sensitivity

For examining this ants' potential skill, the ants of two colonies were trained to an even number (2) *versus* an odd one (5), and the ants of two other colonies were trained to an odd number (3) *versus* an even one (4), and after having checked their conditioning acquisition (thanks to six tests), the ants of the two colonies were tested three times in front of adequately chosen pairs of even and odd numbers. These numbers firstly varied from 2 to 7 to detect the ants' potential parity sensitivity, and then reached 1 and 8 for defining the extension of this skill. To detect the ants' parity sensitivity, the pairs of even *versus* odd numbers presented to ants of colonies A and B were 4 *vs* 3, 2 *vs* 3, 4 *vs* 5, 6 *vs* 5, and the pairs of odd *versus* even numbers presented to ants of colonies C and D were 5 *vs* 6, 3 *vs* 6, 7 *vs* 4, 5 *vs* 4. For each presented pair of numbers, the total area of the dots representing the numbers was identical, all the dots were inside an identical surface (2 cm x 2 cm), and the dots were differently located inside this identical surface. During each test, the ants significantly responded

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essentially to the number of dots having the same parity as that of the number to which they were conditioned, i.e., even for colonies A, B (ants' scores varying between 65% and 100%); odd for colonies C, D (ants' scores varying between 73% and 100%). To define the extension of the pointed - out ants' parity sensitivity, the pairs of numbers presented to ants of colony A and B were 8 *vs* 7, 6 *vs* 7, 2*vs* 1, and those presented to ants of colonies C and D were 7 *vs* 8, 7 *vs* 6, 1 *vs* 2. The ants perfectly responded to the 'correct' parity in front of 1 and 2, very well in front of 6 and 7, poorly in front of 7 *vs* 8, and no longer in front of 8 *vs* 7. Their sensitivity to the numbers' parity is thus valuable from the start of the numerosity (i.e., 1) until the number 7. The latter limit found for *M. sabuleti* leaded to some explanation reported in the discussion section. Numerical results are summarized in Table 2 and partly illustrated in **Figure 6**; they will be detailed in Cammaerts & Cammaerts. (unpublished data).

Ants learned an even number | Ant learned an odd number

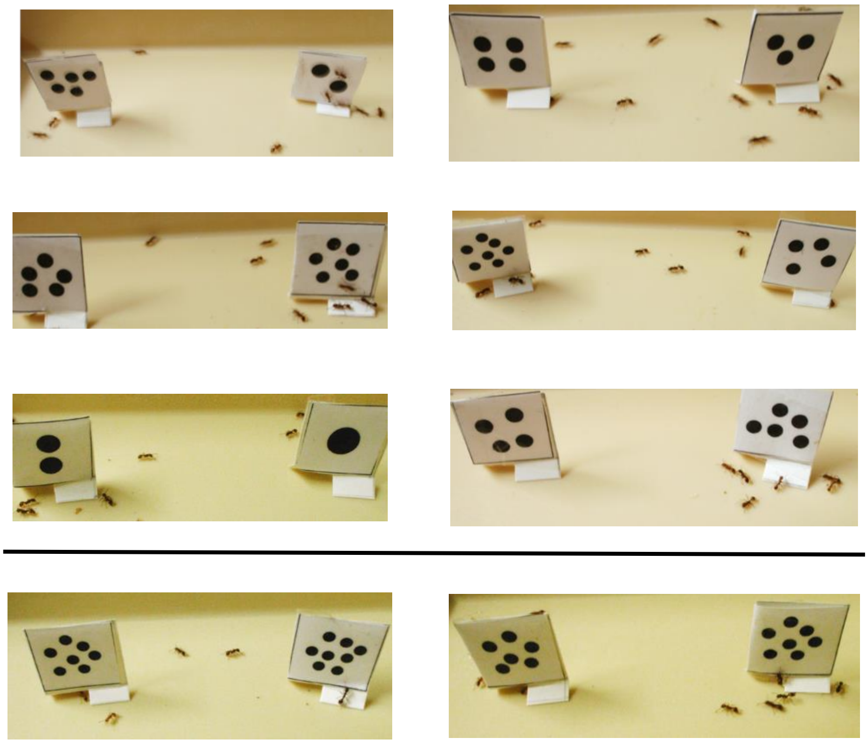

Figure 6. Photos of some experiments made to examine the ants' sensitivity to the numbers' parity. Other photos will be presented in Cammaerts & Cammaerts (unpublished data).

Above the black line: even if not expected, the ants responded essentially to the numbers of dots having the same parity as that of the number seen during training.

Below the black line: this sensitivity is valuable since the start of the numerosity (1 *vs* 2) until the number 7 (6 and 7 are distinguished, 7 and 8 are no longer so).

4. Discussion and Conclusions

4.1 Some Remarks Relative to Authors' Experimental Work

During each study, the differently conducted experiments were in agreement with one another, and the differently performed studies were also in agreement with one another. The results of the authors' successive studies revealed an ants' skill which could be helpful during their daily life: they could forage during the more comfortable time periods (best environmental conditions, less predators), use memorized cues distinguishing the recent and the old ones, use a sequence of odors for finding their way, distinguish even and odd numbers of elements present on their way. A future work will examine if the ants' parity sensitivity is innate or acquired through experiences. Concerning this latter skill, the limit of its extension was found to be the number 7, what is valuable for the species *M. sabuleti,* which has small eyes, a subtended angle of 5° 12', and a poor vision. The limit might be higher for species having a good vision, e.g., *M. rugindis,* a presumption which can be experimentally checked.

All what authors found and here summarize leaded to rather important considerations for humans; theirs' health and daily life.

4.2 Human Considerations Issued from Our Works on Ants

Associating the current time with the occurrence of experienced events is a very useful ability detained by humans, mammals and birds and here found in ants. Indeed, this allows them to adequately act during the time periods presenting the most comfortable environmental parameters, the less possible danger, the most easily performance of the required activity. This associating ability is not innate. It must be acquired and ameliorated all over the live and experienced events. Concerning the humans, parents and any educational persons should be attentive to assure this acquisition and amelioration in children as for the accomplishment of their multiple tasks, e.g., learning, travelling, buying, visiting, playing, and even resting.

Perceiving the passing time, localizing experienced events in the time, projecting aims in the future time, is an essential faculty humans must acquire. In fact, humans have a 'time line' as they have a 'number line', and this 'time line' can be no precise, with only approximate localization of the events, or very well defined for some time periods (e.g., for historians specialized in a define period of the humanity history). In any way, children must progressively learn what is 'yesterday, today, tomorrow, last week, last year, next month, the morning, the afternoon, as well as making tasks in a given time period. Also, time is overestimated when humans are inactive, and this can occur in elderly persons who no longer work, travel, study, write, explain …This must be taking into account while caring of elderly persons: they must be provided with appropriate activities, projects, and tasks to accomplish.

Navigating, finding one's way, is often performed using memorized cues, and children must learn to do so. The most common cues are visual ones (e.g., a house, a tree, a shop), but other olfactory, acoustical, sensory motor, tactile ones can also be used, essentially by persons having a poor visual perception. Paying attention to provide children with such learning allows them having a more comfortable life, this going on when they will be adult.

Humans distinguish even and odd numbers, instinctively when being very young, then more scientifically thanks to learning mathematics (Berch *et al.,* 1999). Such learning requires pedagogic approach (Zazkis, 1998). Working with odd numbers is slower than working with even numbers (Himes, 1990). The number parity sensitivity is more pronounced in women than in men, and influences their choice of many things all over their life (e.g., house, garden, clothes, names, decorations). They should have the full liberty to choose what they prefer, and the more often, they choose what corresponds to an even quantity, not to an odd one. ‘Even’ is kind, female; ‘odd’ is severe, male. This distinction has until now no scientific explanation.

4.3 Conclusions

For most physiological and ethological traits, humans react and behave as animals. After having made experiments on animals, then checking observations in humans, what was found in animals can be applied to humans. A first step for examining a given topic in humans could thus be examining this topic in e.g., ants. Effectively, all along authors’ works in ants, they saw that these insects were excellent biological models, clearly revealing what occurs, rapidly and at low cost resolving some ethological and physiological questions.

Over the eight here summarized works, on the basis of authors’ results, they can state

- that, for having a comfortable adult life, children must learn, during the most adequate time period of their development:

- to associate events with the time period of their occurrence,

- to acquire a define notion of the passing time,

- to be attentive to the fact that when being active, the time seems to pass more rapidly,

- to learn sequences of cues for finding their ways,

- to be sensitive to the numbers’ parity.

- that, concerning the elderly persons, they may progressively lose these five abilities and should thus be, at least for the first four ones, be monitored as for such loss, for ensuring them a rather still comfortable life.

Let us add that several environmental and health factors (e.g., EMF, chemical pollution, artificial light, noise, illness, medicinal products, drugs) may alter the here reported abilities. Attention should thus be paid to treat impacted humans in order to help them maximally recovering the lost abilities. Also, researches on environmental parameters, biological processes and medicinal treatments should be linked.

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