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The 'Mimic' or 'Mimetic' Octopus? A Cognitive-Semiotic Study of Mimicry and Deception in *Thaumoctopus Mimicus*

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Abstract

This study discusses the mimic octopus' (*Thaumoctopus mimicus*) acts of imitation of a banded sea-snake (*Laticauda* sp.) as an antagonistic response to enemies from a cognitive-semiotic perspective. This mimicry model, which involves very close physical resemblance and highly precise enactment, displays goal-orientedness because the octopus *only* takes it on when encountering damselfish, a territorial species, and not other sea animals that the octopus has been shown to imitate, such as lionfish and flounders (Norman et al. 2001). Based on theoretical principles and analytic tools from Mitchell's (1986) typology of deceptive acts, Zlatev's (2008) Mimesis Hierarchy and Zlatev's (2018) types and levels of (self-)consciousness, this research raises the possibility that *T. mimicus* exhibits the following attributes: (i) bodily self-awareness; (ii) cognitive empathy, which builds upon deception and perspective-taking strategies to imagine or project itself into the place of the antagonist; and (iii) capability to reflectively reorganise the standard complete imitation pattern into a partial one in order to optimise its effect, based on conscious visual appraisal of the stimulus position. These capacities would place *T. mimicus* at the dyadic mimetic level on the Mimesis Hierarchy. For this reason, it is suggested that the name *mimic octopus* could be replaced by *mimetic octopus*.

Keywords Octopus *Thaumoctopus mimicus* · Sea-snake mimicry · Body image · Self-awareness · Cognitive empathy · Dyadic mimesis

Introduction

Behavioural complexity in octopuses does not indicate self-consciousness, but it may be suggestive of and set out the basis for it (Mather 2008: 38). These are indeed

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cognitively advanced animals with anatomic, physiologic and complex learning features that resemble those of vertebrates. For instance, octopuses show brain function lateralisation, which is normally linked to consciousness (Klein 1984). Meisel et al. (2011) found that during their sleep time octopuses displayed a typical 'half-and-half' skin pattern exclusively associated with this period of rest. This is regarded as a correlate of mammalian REM sleep, which is commonly linked to consolidation into episodic memory (Mather 2008: 39). Some researchers (e.g. Papineau and Selina 2000) argue that sleep is indicative of animal primary consciousness. In fact, sleep is a phenomenon only registered in vertebrates and certain sophisticated invertebrates (Meisel et al. 2011). Currently, a body of studies of octopus cognition and behaviour thus claim for a *primitive* form of consciousness in octopuses.

Experimental research demonstrates that early learning restriction in cephalopods is highly compensated for by better development of long-term memory if raised in an enriched environment (Dickel et al. 2000). As Mather (2008: 39) notes, this finding is a parallel to the neural and behavioural development of young mammals and to the loosening of the reflexive fixed behaviour programs in human infants. There is evidence of octopuses' capacity for sound decision-making strategies based on observational task-learning. Their extremely flexible arms and highly developed brains governed by integrated organisation rules allow them to create and manipulate categories for adaptive survival purposes (Mather 2008). This combination enables octopuses to make intelligent instrumental choices and repeat them in the future, based on experience. For example, a five-month-old octopus in a Munich zoo learned to open screw-top jars containing shrimp by pressing its body on the lid, grasping the sides with its eight arms and repeatedly twisting its body, a technique that the animal learned by watching human hands do the same task (Adams and Burbeck 2012: 51). Further formal experiments show that captive octopuses can learn to choose the "correct" coloured ball from a pair placed in their tank by observing other octopuses trained to do the task (Adams and Burbeck 2012: 51).

When exploring animal cognitive complexity, very close attention should also be paid to aspects other than behavioural flexibility in task-learning processes, such as specific defensive responses to interspecific individuals in the biosemiosphere. In this regard, octopus mimicry is a research topic that shows great promise since it has been scientifically demonstrated only at the start of this century (Norman et al. 2001) and for the most part studied from an ecological and morphological perspective (e.g. Norman and Hochberg 2005; Hanlon et al. 2008, 2010; Huffard et al. 2010). Some octopus mimicry models go beyond purely physiological faculties and static camouflage (imitation of sessile sea organisms through metachrosis and pre-given morphologic resemblance). They display advanced deception- and motion-based strategies that suggest some degree of cognitive sophistication, and thus, they deserve in-depth research from a cognitive-semiotic viewpoint. These particularly complex instances of interaction spark speculation on attributes such as self-awareness and reflective consciousness. In fact, mimicry is a recurrent topic of discussion on final causation and evolutionary intentionality in contemporary biosemiotics both from a typological, structural and communicative perspective (Maran 2017: 74).

At this point, we should be extremely cautious not to blithely assume high-order faculties in non-human animals. Assuming them is the questionable stance of cognitive ethologists, who overtly express that animals not only have self-evident, high-order conscious intentions, but also beliefs (e.g. Griffin and Speck 2004). Biosemioticians (e.g. Emmeche 2007; Brier 2008; Kull 2010; and Maran 2017) reject this radical position and provide less challenging mimicry models. As Maran (2017: 102) argues, biosemiotics does not rely on abstracted, generic selection processes whereby human senses determine mimetic relations, but it takes more integrative, dynamic, multifaceted factors — such as Uexküll's (1982; 1992) *Umwelt* — into consideration. The Umwelt theory is key to the suitability of biosemiotics because it describes interconnections between the organism's bodily constitution (physiology), particular environment (ecology) and meaning making (Maran 2017: 6).

As with the debate on the cognition of apes between Povinelli and Vonk (2003) on the one hand, and Call and Tomasello (2008) on the other, we can either provide a minimal explanation of octopus cognitive capacities (largely based on mechanical, instinctive performances for survival through e.g. operant conditioning) or suggest that a cognitively rich(er) explanation is possible. The latter position is gradable in nature, offering proposals ranging from moderate but largely empirical to more speculative and less palatable hypotheses. What is safe to argue is that mimicry *is* an aid for certain psychological properties and capacities, such as semiotic co-option and cognitive scaffolding, to develop (Maran 2017: 114).

Taking Maran's (2017: 114) claim above as a reference, this paper explores the cognitive-semiotic grounding of a mimicry pattern exhibited by the octopus species *Thaumoctopus mimicus*, commonly known as *mimic octopus* by marine biologists. *T. mimicus* has been found to often engage in the imitation of a banded sea-snake as an antagonistic response to damselfish. This mimicry type consists of very close physical resemblance of the model and a highly precise enactment of its movements. As will be shown, specific perceptual and cognitive aspects of the sea-snake imitation easily lend themselves to debate and trigger stimulating discussion.

This study is inspired by previous research into other mimicry strategies of *T. mimicus*. For example, drawing on genetic DNA sequence findings and clade evolution analysis, Huffard et al. (2010) prove an earlier prediction (Huffard 2006) wrong to conclude that deceptive flatfish swimming in *T. mimicus* is *not* a form of exaptation, according to which certain traits are fit for their current role, but were not designed for it because they originally evolved either as adaptations for other uses or inextricably linked to other selected traits (Huffard et al. 2010: 70). Rather, flatfish swimming imitation in the mimic octopus is an example of facultative adaptation — a more sophisticated survival mechanism than exaptation —, involving anatomical changes (exceptionally long arms) and corresponding behavioural uses (dorsoventrally compressed swimming) that evolved at the same time (Huffard et al. 2010: 70). This finding encourages research into the sea-snake imitation model, addressing it as a particularly challenging type of facultative adaptation, as done by this paper.

The structure of this article is as follows: Section 2 presents the mimic octopus, and thoroughly describes and analyses the stages and skills that the sea-snake imitation type builds upon by providing underwater camera footage as visual support. Reasons are given why we find certain mimetic effects striking, and why they invite reflection. Section 3 makes an overview of Mitchell's (1986) four-level typology of deception in nature and Zlatev's (2008) theory of meaning-making from a cognitive-semiotic perspective, known as *Mimesis Hierarchy.*[1] Both serve as the theoretical and analytic framework used by this research to describe the sea-snake mimicry and give it a position in the respective hierarchical classifications. Section 4 proposes an account of the sea-snake imitation by comparing and integrating premises from the work of Mitchell and Zlatev. Firstly, a minimal, parsimonious explanation to the phenomenon is provided; secondly, a richer, tentative explanation is given, whereby the position of *T. mimicus* on the Mimesis Hierarchy is changed. This is done by also considering the *Phenomenological Semiotic Hierarchy*, another cognitive semiotic model by Zlatev (2018), which offers a classification of levels of consciousness.

The Mimic Octopus: Description of its Deception Capacities

The current documented distribution of the mimic octopus (*Thaumoctopus mimicus*) extends from the Red Sea to New Caledonia (Nabhitabhata and Sukhsangchan 2007; Coker 2013: 2). However, this is an Indian Ocean species mostly occurring in Lembeh Strait, Northern Sulawesi, Indonesia. It was discovered to display a wide repertoire of postures and body patterns that work as imitations of other sea animals. *T. mimicus* has been found mimicking both stationary — colonial tunicates, sponges, and tubes of polychaete worms (Hanlon et al. 2010: 15) — and mobile organisms co-occurring in its habitat, such as lionfish and banded sea-snakes (Norman et al. 2001). The film clip at https://www.youtube.com/watch?v=H8oQBYw6xxc[2] illustrates each of the mimic octopus' conspicuous imitation models of travelling organisms: a flatfish, a lionfish, and a banded sea-snake. All three serve the same purpose: to avoid potential predators and territorial adversaries by mimicry and deception.

Sea-Snake Imitation Model: Fully-Fledged Impersonation

The octopus' impersonation of a venomous banded sea-snake (*Laticauda* sp.) is especially revealing. The focus of analysis in this paper is laid on this mimicry model because it constitutes a particularly sophisticated semiotic strategy from a cognitive, perceptual, and behavioural (bodily enactment) point of view. This imitation pattern has been discussed in animal ecology (Norman et al. 2001; Hanlon et al. 2008) and mentioned in taxonomic biology studies (Norman and Hochberg 2005). Nevertheless, little research has been done into its implications for cognitive psychology and cognitive semiotics.

Importantly, the sea-snake imitation supersedes the flatfish and lionfish ones in complexity due to the following factors: (i) the flatfish and lionfish imitations do not

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[1] The concept of mimesis sensu Zlatev should not be mistaken for the traditional concept of mimesis (e.g. Heikertinger 1925; Pasteur 1982). The latter specifies mimicry based on resemblance, such as cryptic and phaneric mimesis. In both subtypes of mimesis, the mimic resembles, with its body form and patterns, the physical or living element of the environment, such as stones, twigs, fungi, and plant leaves) (Maran 2017: 18). As this study will show, Zlatev's types of mimesis and its different levels of complexity exclusively refer to performative programs, ranging, not exhaustively, from purely reflexive (proto-mimesis) to reflective acts (e.g. linguistic communication).

[2] This is a 2:59 min long videoclip extracted from the full-length TV documentary *Wild Indonesia - 02.Underwater Wonderland*, owned and broadcasted by the *British Broadcasting Corporation*. The videoclip was last accessed on 27 May 2019.

necessarily require close octopus-antagonist interaction, while the sea-snake imitation does; (ii) some of the semiotic structures and processes operating in the sea-snake mimicry plan strike the viewer as puzzling and unexpected in cephalopods, whereas all of the structures and processes playing a role in the flatfish and lionfish models have already been documented at this level on the scale of biological evolution.

The description and discussion of the perceptual and cognitive faculties underlying the behavioural patterns of *T. mimicus* draws on filmed materials that supplement a scientific experimental field study conducted by octopus experts Norman et al. (2001). These marine biologists video recorded different individuals in the *Thaumoctopus mimicus* species producing the appearance of a sea-snake on as many as four occasions and only when the cephalopods were attacked by highly territorial damselfishes[3] (*Amphiprion* sp.) (Norman et al. 2001: 1757). Otherwise, the octopuses adopted a variety of other marine animal mimicry models — either unequivocally identified by scientists, such as flatfish and lionfish, or more tentative, such as brittle stars, mantids, and seahorses (Hanlon et al. 2010: 22). Although not unique to the mimic octopus, the faculty of adopting a form best suited to the perceived threat at any given time is indicative of advanced cognition.

A careful examination of the sea-snake imitation videoclip reveals a fully-fledged impersonation of a sea-snake in the species *Laticauda colubrina*. This impersonation is remarkable for several reasons. First of all, the two arms of *T. mimicus* that mimic the banded sea-snake *Laticauda* display the same black-and-whitish-grey colour code as the body of this snake species (see screen capture in Fig. 1). An upgraded imitation of this colour pattern is achieved by *T. mimicus* by applying a set of integrative deception strategies. Specifically, this cephalopod introduces one black dot on each side of the end tip of the arm playing the anterior fragment of the snake. In turn, the tip is conspicuously made fleshy and rounded to take on the stereotypic globular, though tapering, shape of snake heads. This way, *T. mimicus* refines the mimicry model by adding fake eyes to the adaptively shaped head of a banded sea snake (Fig. 2).

In addition, *T. mimicus* constructs a full three-dimensional model of a sea-snake by attaching two of its arms together in longitudinal contiguity (see Fig. 1 and videoclip at 2:13). The impersonation certainly looks complete — and thus, more deceptive — when including both the anterior and posterior halves of a snake's elongated body. Moreover, the thickness of the imitating arms gradually becomes thinner from head to tail, following a tapering pattern characteristic of snakes. In addition, the arms make fine-tuned movements, which very closely mimic not only the curling body of a snake, but also the undulating, wave-like move that it performs in (loco)-motion. As Norman et al. (2001: 1755) explain, six arms were threaded down a hole and two were raised in opposite directions, banded, curled and undulated.

This range of creative refinements of the banded sea-snake mimicry model is meant to scare the damselfish off more effectively, intimidating the fish and keeping it on the alert. Importantly, these fine-grained strategies provide empirical evidence of the mimic octopus' outstanding observational skills to recognise and richly impersonate entities in its environment.

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[3] See film clip at https://royalsocietypublishing.org/doi/suppl/10.1098/rspb.2001.1708 for a longer footage of the sea-snake imitation (clip provided by Norman et al. 2001).

Fig. 1 Fully-fledged imitation of a banded sea-snake by mimic octopus

Sea-Snake Imitation Model: Partial Impersonation

Apart from the imitation display in which the mimic octopus brings two of its arms together for a full model of the sea-snake, the video footage also shows a second mimicry type (starting at 2:13). As Fig. 3 shows, the octopus only raises one arm to partially mimic the body and movement of a sea-snake — specifically, the anterior (first-half) fragment of its body, which includes both the fake snake head and eye. The second half of the snake body, which would emerge after attaching another arm, has not been added to the imitation display.

Fig. 2 Zoomed-in image of octopus arm end showing a fake, tapering snake head and a fake eye on it (orange arrow)

Fig. 3 Partial imitation of a banded sea-snake by the mimic octopus

Two more differences between the two models can be identified: in the partial impersonation, (i) the fake snake head is pointier (less fleshy), (ii) and the fake snake body has widened significantly, in contrast to the much thinner shape displayed in the fully-fledged mimicry type.

Based on this new scenario, the following research questions are in order:

(i) Why does the mimic octopus make this notable change in its imitation system?
(ii) Is the shift from a complete to a partial imitation model (also including the widening of the imitating arm and a pointier fake snake head) intentionally deceptive?
(iii) Is this patterning a (one-off) discriminatory behaviour by one specific individual in the *T. mimicus* species or is the patterning applicable to and recurrent in other individuals in the species?

As mentioned above, both a minimal and a rich explanation can be given to answer these questions. The two types of explanation are provided in detail in Section 4. At this stage of analysis, we have simply limited ourselves to bringing a surprising and intriguing change in a mimicry type to the scientific community's attention.

Theoretical and Analytic Framework for a Rich Explanation of the Sea-Snake Imitation Models

To raise hypotheses about the cognitive-semiotic skills of the mimic octopus, it is firstly necessary to have a robust theoretical and analytic framework. This section outlines the principles of the two typologies that are regarded as most useful to account for the comparison of the two sea-snake mimicry types exhibited by *T. mimicus*. These typologies are Mitchell's (1986) four levels of deceptive behaviours in nature and Zlatev's (2008) Mimesis Hierarchy, an approach to meaning-making from a cognitive-semiotic perspective.

Mitchell's Four Levels of Deception

Before presenting the typology of deceptive acts used in this paper, it should be clarified that mimicry is a multifaceted biological phenomenon, which can be approached from different theoretical and practical perspectives in science (Maran 2017: 10). For the purpose of this study, however, there is an aspect of mimicry that is central to the argumentation of the sea-snake imitation model: the assumption that mimicry derives from the semiotic and ecological relations of different living organisms (Maran 2017: 10). If we focus on the semiotic dimension of the sea-snake imitation by *T. mimicus*, mimicry can be defined as "a resemblance of messages (cues or signals) of one organism to the messages originating from another being (that usually belongs to a different species), or to some feature of the environment, or to generalisations of either of those" (Maran 2017: 9).

As for its ecological dimension, the mimicry model addressed in this paper involves predatory relations, so in this case it is justifiable to narrow down the understanding of mimicry as *a kind of deception*, which is achieved by a living organism (the mimic/sender) by simulating signal properties of a second living organism (the model) that are perceived as signals of interest by a third living organism (the operator/receiver), such that the mimic gains in fitness as a result of the operator identifying it as an example of the model (Vane-Wright 1980: 4).[4] This definition of mimicry emphasises the roles of the communicative and behavioural process and the interpreting organism (Maran 2017: 9). Because the type of mimicry analysed in this study is regarded as a kind of deception, using a classification of deceptive behaviours in nature as a backdrop for the mimic octopus research is in order.

There is a good repository of mimicry meta-typologies that have been proposed by the literature over years of observation of the natural world (e.g. Poulton 1890; Endler 1981; Pasteur 1982; Komárek 2003). Many of them are highly informative and comprehensive within their scope of analysis because they do not only consider mimicry itself, but also adjunct structural and functional adaptations, such as the multiple subtypes of crypsis, aposematism, polymorphism, and convergence. As a result of this integration, traditional mimicry types — Batesian mimicry, Müllerian mimicry, and aggressive mimicry — can be reinterpreted differently by scholars since "opinions about the delineation of the mimicry concept and its relations with neighbouring phenomena differ" (Maran 2017: 16) and/or merge into novel ones as researchers report on new forms of resemblance and deceptive behavioural patterns.

Nevertheless, meta-typologies analyse mimicry basically as a rigid, static system or structure that provides poor or insufficient insights into the semiotic and communicative processes of the mimicry types. In order to make distinctions between the two sea-snake mimicry displays from a dynamic cognitive-semiotic point of view, animal psychologist Mitchell's (1986: 3–40) typology of deceptive acts in nature may be used. Together with Zlatev's (2008) Mimesis Hierarchy (addressed below), Mitchell's typology enables us to give sense to the behavioural dynamics of the sea-snake imitation models as approached

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[4] It should be noted that although most mimicry cases are indeed based on predatory relations, mimicry also exists in other ecological relations and functions, such as symbiosis, parasitism and competition (Maran 2017: 8). This fact provides evidence of the *multifaceted nature of mimicry*, a phenomenon that changes in time and is dependent on the varied activities of the partakers (Maran 2017: 10).

from the positions of the mimic and the receiver, and determine what the different strategies are that the mimic can use to cope with the receiver in the mimicry act.

Mitchell distinguishes four levels of deception according to the sender's freedom to act. Table 1 includes these levels and summarises the features that characterise each of them. A detailed description of the levels and their features is done further below.

On the first level, the sender deceives because it has been physically designed (morphology- and/or colour-wise) to do so and cannot do otherwise. There is only pre-given resemblance because of genetic and evolutive pressure on the individual's *appearance*. Two good examples are the Tettigoniid insect, commonly known as *bush cricket* (Fig. 4), and the pygmy seahorse (Fig. 5). Because of their colour patterns and anatomies, the bush cricket and the pygmy seahorse look very much like a plant leaf and its home coral, respectively. These are instances of eucryptic mimicry, i.e. a camouflage-driven deception strategy by which the imitating organism matches its surroundings to go totally undetected. The model is indifferent to the receiver, which guarantees protection to the sender (the mimic).

On the second level, deception is also predetermined, but for its expression, the sender needs to come into contact with the receiver and trigger the deceptive demonstration actively. In this case, deceiving does not require learning since the organism can be described as programmed to do p given that q is the case, where p and q are actions of the sender and receiver, respectively (Mitchell 1986: 24). Stock examples are injury-feigning and snake-mimicking by some birds upon viewing particular types of predators. Importantly, each bird injury-feigning and snake-mimicking model preserves its deceptive motor behaviour, following an orderly performative program with no (improvised) modifications. This means that each imitation model only relies on a (most times) monolithic and instinctive *coordination of perception and action*, ruling out the possibility of specialised, learned behaviour.

On the third level, the organism's actions are the result of an open program that can be modified by the results of the actions of, and by the observations of, the organism (Mitchell 1986: 25). As a result, the sender is capable of customising the pre-existing behavioural patterns and repeating the successful deceptions based on experience and trial-and-error, instrumental, and/or observational *learning*. For instance, some birds' singing of a variety of learned song repertoires was an enhanced version (in aspects such as intensity and pitch) of more basic singing patterns because, by creating the illusion of a crowded habitat, the customised singing dissuaded new birds from nesting

Table 1 Mitchell's (1986) deception levels according to the sender's freedom to act

Levels of deception	Characterised by
Pre-given resemblance	genetic and evolutive pressure on physical appearance
Predetermined behaviour	instinctive coordination of perception and action, ruling out the possibility of specialised, learned behaviour
Customisation of pre-existing behavioural patterns	learned, intentional acts, though not intentionally deceptive
Intended deception (such as lying)	self-awareness, recognition of the other animal's beliefs about (past) actions, and planning/self-organisation to achieve intended deception

Fig. 4 Bush cricket, which resembles a plant leaf for camouflage

nearby. On this level, an animal's act can be considered intentional, though not *intentionally deceptive*. That is, the animal can act because it believes its action will have a particular result, though the animal has no recognition of what the other animal effecting that result believes about the action (Mitchell 1986: 25).

On the fourth level of deception, which is characteristic of humans and to some extent of other anthropoids too (Mitchell 1986: 26, 27), the sender takes into consideration the past activities of the receiver and can customise deception depending on the receiver's current behaviour and response in a particular communicative situation (Mitchell 1986: 27). This capacity involves recognition of the other animal's beliefs about actions and *planning*/self-organisation to achieve the *intended* deception (self-programming in advance). The sender's action being intentionally deceptive means that the sender recognises that it/he/she is deceiving. Importantly, to produce a fourth-level

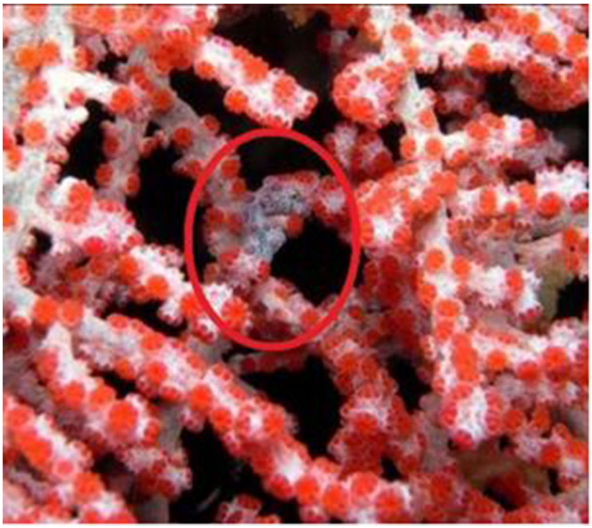

Fig. 5 Pigmy seahorse (encircled), which resembles the corals in which it lives for camouflage

deception requires self-awareness (Mitchell 1986: 30). A telling example in non-human animals is provided by Menzel (1974: 134-5), who reports on a chimp moving in a direction away from hidden food, as if she was heading towards it, only to run back to the place where the food really was when a second chimp was ahead of her in the wrong direction to get the food and not observing her. Such a misleading behaviour is clearly intentional, and requires conscious planning and self-programming on the part of the first chimp and knowledge of what her action meant to the second chimp.

Zlatev's Mimesis Hierarchy

For a thorough cognitive-semiotic analysis of the two types of sea-snake mimicry, Mitchell's typology needs to be supplemented by a fine-grained analytic apparatus, which clearly defines the semiotic structures and processes attributed to *T. mimicus* and matches them with their corresponding markers and behaviours. In other words, it is necessary to couple and enrich the structural levels of deception with their correlates at different semiotic levels. For this purpose, we may draw on the Mimesis Hierarchy (Zlatev 2008, 2009, 2013), which builds upon evidence from primatology, and child development. A cross-species approach to meaning-making, the Mimesis Hierarchy gives insights into semiotic development by establishing five levels on the scale of evolution and ontogenetic development with a view to describing the different *types of mentality*, that is, the various kinds of states and processes of consciousness (Zlatev 2008: 237).

Determining the types of mentality involves scaling all the way up from *primary subjectivity* to the most sophisticated feature of human *inter*subjectivity: language. The five levels of the model are thus characterised by incremental features and corresponding cognitive-communicative skills. Table 2, extracted from Zlatev (2009: 193), includes the acts that characterise each level on the Mimesis Hierarchy.

Cross-modal mapping, the feature that identifies proto-mimesis as the first level of the Hierarchy, relates to a predetermined performative program with most times no modifications or adaptability. If the demonstration is adaptive to different situations, the adaptation action is purely reflexive and pre-conscious. Therefore, cross-modal mapping matches Mitchell's *coordination of perception and action* at the second level of his

Table 2 Levels on Zlatev's (2009: 193) Mimesis Hierarchy and corresponding incremental acts

Level	Characterised by acts which are
Language	divided (semi)compositionally into meaning sub-acts that *systematically* relate to other similar acts (as in grammar)
Protolanguage	*conventional-normative*
Triadic mimesis	*intended* to stand for some action, object or event for an addressee (and for the addressee to recognise this intention)
Dyadic mimesis	under conscious control and *corresponding* —either iconically or indexically— to some action, object or event, and at the same time being *differentiated* from it
Proto-mimesis	based on a *cross-modal mapping* between exteroception (normally dominated by vision) and proprioception (normally dominated by kinesthetics)

typology. The intersubjectivity skills in proto-mimesis are simple empathy, mutual attention/gaze, as well as neonatal imitation. The corresponding type of mentality on this level is of first order, involving lack of complete differentiation between self and other (Zlatev 2008: 237).

At the second level is dyadic mimesis, which presupposes the following skills: cognitive empathy, shared attention (Zlatev's *I see that you see X* paradigm) and understanding other's intentions. The type of mentality is of second order, and consists in projecting one's perceptual and motivational state onto the other to understand their intentions. This corresponds to the definition of *cognitive empathy* proposed by Preston and de Waal (2002: 18): "the differentiation between subject and object where the subject is thought to use perspective-taking processes to imagine or project into the place of the object".

The mimetic acts at the dyadic level are clearly intentional (Zlatev 2009: 193), entailing the *conscious* control of one's body movements and the *conscious* attention of their correspondence to the body of another (Zlatev 2008: 225). (Self-)consciousness at this stage is particularly important to our argumentation in Subsection 4.2. Although clearly intentional, the mimetic acts at this level are not meant by the sender of the signal to be understood as communicative by the receiver. In terms of deception, this means that an animal's act can be considered intentionally deceptive, though not consisting of an intentionally communicative misleading *sign.*[5] Drawing on past experience, the sender performs an act effectively since it is able to put itself in the receiver's position, but the act is *not* a form of intentional communication. In other words, the sender has the intention for the signal to be directly understood by the addressee as the 'real thing', but the sender does not — because it actually can*not* — have the intention for the signal to work as a sign, and thus, be understood as such both by the sender and the addressee.

For this reason, dyadic mimesis largely correlates with the third type of deceptive acts in Mitchell's typology. For example, it has been shown that ape *A* can limp to trick ape *B* into thinking that *A* is hurt, resulting in *B* not bothering *A* (Zlatev 2008: 228). This behaviour does not mean that *A* wishes *B* to understand that *A* is *faking* a limp (as this would be counterproductive), but it is just that *A* finds its strategy effective, based on previous experience. Imperative pointing, used to make the addressee do something for the subject (e.g. *give me that*), is also an instance of dyadic mimesis (Zlatev 2014: 203).

At the third level on Zlatev's Hierarchy is triadic mimesis, which involves joint attention, having and understanding communicative intentions and a third-order type of mentality. Zlatev's *I 'see' that you see what I see* and Brinck's (2001) *I realize that you want me to look at X* paradigms operate at this rung of the hierarchy. Declarative pointing, used to manipulate the addressee's attention for its own sake (Brinck 2003: 429), is a clear instantiation of triadic mimesis because it is a *sign intended* to be understood by the addressee as standing for an action (intentional communication) or to call for joint attention (e.g. *look at that*). Triadic mimesis has only been documented in

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[5] This paper is in line with Zlatev's (2008, 2009) approach to the term *sign*, which necessarily entails understanding that a representation has the same meaning for the addressee as for the sender. This requires a sender-addressee agreement, which enables (successful) communication. A sign is intended to be understood by the addressee as standing for an object, event or action, not for 'the real thing'. Every act is "meaningful" in the broad sense of semiosis (meaning making), but not in the sense of using signs.

humans and richly trained, encultured apes (Zlatev 2008: 231). Deception at this level can occur, for instance, when trained chimp *A* diverts chimp *B*'s visual attention to a distracting item/place that *A* is misleading pointing at, enabling *A* to furtively conceal an object *X* that (s)he would not like to share with *B* (this thus means that *A,* drawing on past experience, is aware that *B* is interested in *X*). *A*'s intention to communicate *look there*, encapsulated in the finger-pointing sign, is understood by *B*, which is consequently deceived. This is thus a knowingly intended deceptive case of sign use (misleading intentional communication).

Triadic mimesis is only partly on a par with Mitchell's fourth level insofar as both categories presuppose intendedly deceptive communication and planning, based on the deceiver's knowledge of what his/her action means to the deceived (the observer) and on the deceiver's knowledge of the deceived individual's past behaviour and desire. Triadic mimesis, however, does not involve beliefs and propositions (Zlatev 2008: 238). A belief is a propositional representation that is actively held to be true, following the order thought *I expect that you and I are interpreting sign X in the same meaningful way* (Zlatev 2008: 234). Triadic mimesis is thus *not* about expectations, but about taking something for granted without pondering on whether or not it is true[6] (as the enculturated ape *B* in the example above and four-year-old children do). Mitchell does not make this fine distinction in his typology, so that he includes both communicative intention understanding *and* (false) belief understanding at the fourth level of classification. Belief understanding exclusively occurs at post-mimesis stages on Zlatev's Hierarchy.

Post-mimesis$_1$ (protolanguage), which stands fourth on Zlatev's Hierarchy, entails the use of fully conventional-normative (i.e. consensual) signs, as is the case for all human languages (Zlatev 2008: 232). The associated intersubjectivity skill is the use of semantic conventions and the type of mentality is based on the *I know that you know that I know X* paradigm. For this reason, this is third-order mentality where expectations play a pivotal role. All great apes can develop a *rudimentary* (emphasis intended) signed language, showing that post-mimesis is not fully beyond their grasp.

Post-mimesis$_2$ brings language with it. The corresponding intersubjectivity skill is the understanding of (false) beliefs, that is, metarepresentational capacity or having thoughts about someone else's thoughts in response to a statement or event (third-order and higher mentality). Language and metarepresentational capacity are privative of human beings. The capacity to lie (that is, to deceive by means of language) is included in Mitchell's fourth level, and is considered the most advanced modality of deception.

Table 3 shows the correlation (matches and overlaps) between the four levels in Mitchell's (1986) typology of deceptive acts in nature and the five levels in Zlatev's (2008, 2009) Mimesis Hierarchy. As can be seen, there is no correlate of Mitchell's first level on Zlatev's Hierarchy. Mitchell's first level refers to the simplest form of deception — that is, null freedom of act in deceiving because there is actually no bodily act*ion*, but just physical resemblance to the imitation model. Thus, this is a *pre*-mimetic level where meaning-making acts are *purely operative,* corresponding to what Zlatev (2018: 6, 15) classifies as *operative intentionality,* in the sense of Merleau-Ponty (1962). Operative

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[6] There are researchers, however, who argue for the propositional nature of biological signals in mimicry. For example, Queiroz et al. (2014) analyse the capacity of producing propositions (*dicisigns* in Peircean terms) as a general requisite for a mimicry-based semiotic system to arise, given that dicisigns also exist in communicative systems other than human language, such as pictures and gestures. They conclude that propositions can also be found in biology as simpler dicisigns, as is the case for fireflies' deception strategies.

Table 3 Leve l matching and overlaps between Mitchell (1986) and Zlatev's (2008, 2009) models

Mitchell	Zlatev
First level	–
Second level	Proto-mimesis
Third level	Dyadic mimesis
Fourth level	Triadic mimesis
	Proto-language
	Language

intentionality refers to the basic level of meaning, to organic individuality, to life itself, which inherently aims at its own preservation and continuation, being purely teleological in nature (Zlatev 2018: 6). Zlatev (2008) leaves this category outside the Mimesis Hierarchy because he sets out to characterise meaning stratification with primary subjectivity (proto-mimesis) as the lowest, most primitive level.

Finally, Table 3 also shows Mitchell's fourth level as a broad category, where triadic mimesis, proto-language and language would fit in. As explained above, in contrast to this less specific level, Zlatev provides a narrower, finer-grained classification, with more concrete semiotic features characterising each hierarchy level.

Interpreting the Meaning-Making Acts of *Thaumoctopus Mimicus*

Once Mitchell and Zlatev's typologies have been described and compared, the aims of our study at this stage of the research are the following:

(i) to categorise the perceptual attributes and behavioural characteristics of *T. mimicus* as instantiations of deception within a particular rank in Mitchell and Zlatev's typologies;
(ii) to spot and characterise the capacities in the mimic octopus that seem to fall outside the limits of such ranks;
(iii) based on the capacities that resist the standardised categorisation, to reconsider *T. mimicus*' position in Mitchell and Zlatev's classifications (as Maran 2017: 27 very aptly notes, mimicry in nature is a complex phenomenon that does not always submit well to rigid classificatory schemas).

Maran (2017: 86) writes that mimicry can be described as fixed or adjustable, partial or complete, local or general, individual or collective, and embodied or detached. The two sea-snake imitation models exhibited by *T. mimicus* have been shown to belong to an adjustable system, allowing for a partial and a complete mimicry pattern. The complete one has been found to be performed by different individuals in the species both in laboratory conditions and in the wild. By contrast, the partial one was only filmed in the wild — and to the best of our knowledge — the video at https://www.youtube.com/watch?v=H8oQBYw6xxc is the only footage of a mimic octopus performing this specific impersonation and showing this particular body arrangement (widened arm, pointed arm tip *and* arm torsion).[7]

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[7] Norman et al. (2001: 1755) produced over 6 h of video footage.

This fact addresses research question (iii) presented in Subsection 2.2.: Is this partial patterning a (one-off) discriminatory behaviour by one specific individual in the *T. mimicus* species or is the patterning applicable to and recurrent in the rest of conspecifics? With only one piece of evidence, further field- and laboratory work is necessary in an attempt to film more than one mimic octopus playing the partial sea-snake mimicry model. This way, we will be able to draw compelling conclusions about the individual or collective nature of this particular imitation pattern and empirically work out what the reasons are for *T. mimicus* to implement it. By the same token, once shown that octopuses make individual choices of eyes for looking (Byrne et al. 2002) and that individual octopuses each have a favoured arm of the eight for reaching tasks (Byrne et al. 2006), it is an exciting challenge to determine what a or — most interestingly — *the* specimen in the *T. mimicus* species does with its neural equipment and environmental influences when engaged in the partial sea-snake mimicry display.

In the reminder of this article, *T. mimicus*' sea-snake mimicry types are put in place in Mitchell and Zlatev's typologies — firstly from a parsimonious perspective, secondly from a richer perspective. For this purpose, retrieving questions (i) and (ii) posed in Subsection 2.2. is in order:

(i) Why does the mimic octopus make this notable change in its imitation system?
(ii) Is the shift from a complete to a partial imitation model (also including the widening of the imitating arm and a pointier fake snake head) intentionally deceptive?

In order to answer these questions, two key factors should be considered: a) the topology of the physical setting where the mimic octopus and damselfish encounter each other (in this case, the burrow in the sand where the octopus hides most of its body — probably its den — is an essential element of the topology); b) the position and posture of the mimic octopus with respect to itself and to the damselfish.

A Minimal Explanation

At an initial stage of analysis, the mimic octopus' sea-snake mimicry types can orthodoxically be regarded as deception examples belonging to level two in Mitchell's typology. Consequently, we are strictly adhering to the standard semiotic structures and markers that characterise the second level of his classification, and thus, assuming the conventional view that the complete and partial postures are but instinctive, designed responses to threat, only involving adapted though *pre*determined coordination of perception and action.

This argumentation is a minimal, parsimonious explanation to the phenomenon, according to which a change in the mimicry program from a complete to partial model corresponds to a *purely* refle*x*ive (not refle*c*tive, innate) strategic reaction to a greater threat: the octopus feels that it is in higher danger for standing closer to the damselfish, which compulsively moves back and forth to block the den entrance that the octopus would like to reach. As a result, the cephalopod exclusively raises not two but one arm to only construct a partial sea-snake imitation model. *T. mimicus* is programmed to do *p* (partial imitation) given that *q* (the damselfish has come dangerously close to the octopus) is the case. This simpler, less cumbersome physical arrangement will be less of an obstacle for the octopus to impulse itself away for a (much) quicker retreat in the event of an attack by the damselfish. Detaching two arms and fleeing requires a bigger physical effort — and above all — more time, which would put the octopus' physical integrity at serious risk.

A widened arm and a pointier arm tip are likely to be the result of muscle tension (strained arm muscles) triggered by a stressful, risky episode. *T. mimicus* thus offers a simplified version of the imitation to the detriment of the finest version in the presence of immediate danger. In other words, the greater the threat and lower the reaction time to escape, the poorer the mimicry model. Apart from stress, the octopus may have strained its arm wider and pointer at its end in order to direct the arm backwards. In Fig. 3 above, the octopus' head seems to be facing forwards (also notice the front position[8] of four of its seven arms resting on the seabed), in the opposite direction from where the damselfish is. Given this position, *T. mimicus* has to turn its imitating arm backwards to point at the signal receiver, resulting in the octopus' arm undergoing mechanical torsion and stretching and its tissue expanding in the direction of the stimulus. According to a minimal explanation, this behavioural scheme boils down to exclusively physical constraints and primitive impulses, to an adapted but pre-conscious coupling of visual sensing and action conditioned by the position and posture of the mimic octopus with respect to the damselfish.

If the same minimal argument is held in terms of Zlatev's model, adjustments in the sea-snake mimicry programme can be claimed to be a case of proto-mimesis — specifically, a flexible but still pre-given, instinctive response (cross-modal mapping) to imminent danger. The octopus is not self-aware, and is incapable of completely differentiating between itself and the other (the damselfish). Lacking body self-consciousness and capacity for reflection, the octopus is not aware of its position or its antagonist's position in space. As a proto-mimetic organism, the mimic octopus entirely operates through its *body schema*, a concept firstly introduced by Merleau-Ponty (1962) and elaborated by Gallagher (2005), to designate an innate and *pre*-conscious manner of being in and interacting with the world (Zlatev 2008: 223).

T. mimicus' arm widening nicely fits in with Nordlander's (2011: 48) view of *body schema*, which "continuously negotiates an organism's interaction with its surroundings through the contraction and release of muscles, the coordination of the movement of the limbs, and the posture of the body and its balance". In terms of deception, this means that *T. mimicus* is not *intentionally* adapting its body (only raising one imitating arm) to mimic a sea-snake (it lacks dyadic mimesis), let alone having the misleading *communicative* intention to use its arm as a sign to confuse the damselfish (it lacks triadic mimesis). Such a modification in the deception act is but an irreflective, life-preserving strategy to cope with danger, as with hunting and mating in case of hunger and sexual drive, respectively.

A Rich(Er) Explanation

As Mitchell (1986: 28) argues, the available information about a deceptive action may suggest its classification at a particular level, whereas an explicit (in-depth) description

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[8] Octopuses have been proven to be bilaterians, that is, they are bilaterally symmetrical animals with a front and back, and hence a left and right, as well as a top and bottom (Godfrey-Smith 2016: 22).

of the development of this action might suggest a more accurate placement at another level. The identification of a partial imitation model as an alternative to the most common standard display is indicative of flexible imitation patterning. This finding invites the questions as to whether the octopus' perceptual processing of its and the receiver's position in space during the semiotic act has a bearing on the type of mimetic schema displayed.

Levels and Types of (Self-)Consciousness

At this point, it is highly instrumental to retrieve Maran's (2017: 86) claim that mimicry can be described as *embodied or detached*, which specifically rises the dilemma whether the mimic octopus is aware of its own body and is able to differentiate it from that of others in a detached manner. The dilemma inevitably brings (levels of) consciousness into the picture, and highlights the importance of making use of these levels for the characterisation of the cognitive-semiotic skills of *T. mimicus*. Mitchell (1986) does not spell out perfectly delineated, well-defined types and levels of consciousness and (self-)awareness when describing his typology. Zlatev (2009) lays the ground for an articulate classification in his Semiotic Hierarchy, which has recently been elaborated with the help of phenomenology (Zlatev 2018). For a rich explanation of the partial sea-snake imitation model, it is necessary to make specifications of the "various kinds of states and processes of consciousness" that are immanent to the different types of mentality (Zlatev 2008: 237) without discarding unconsciousness — or, as Zlatev (2018: 9) opts to name it, *pre-consciousness*. Indeed, specifications in the description of the sea-snake imitation model are not only necessary to deal with the (non-discrete) transition from the *living body* to the *lived body* (concepts suggested by Husserl 2001), but also — and especially — to cope with the transition from *body schema* to *body image*.

To this aim, the present study draws on the three states in which meaning (phenomenologically understood as the relationship between the subject and the world) may emerge, as suggested by Zlatev (2018) in the most recent version of his Phenomenological Semiotic Hierarchy.[9] Such states are (i) pre-consciousness, (ii) pre-reflective self-consciousness or primary subjectivity, and (iii) reflective (or explicit) self-consciousness. Pre-consciousness resides at the most basic level of meaning-making, which is primordial to *all* living beings as a way to fulfil organic individuality or *operative intentionality* (Zlatev 2018: 7–8). Pre-consciousness is meaning-making at the level of *life*, involving the living body, i.e. the purely animate, organic body that inherently aims at its own preservation and continuation (operative intentionality). For this reason, pre-consciousness is tightly related to body schema, which constitutes a "system of sensorimotor capacities that function without awareness" (Gallagher 2005: 24).

Pre-reflective self-consciousness characterises what Zahavi (2014) calls a *minimal experiential self*, the very basic form of the lived (phenomenal) body. This basic form entails *un*thematic (i.e. implicit) conscious experience, with non-observational access to oneself; however, it involves *perceptual intentionality*, that is, the subject (the self) not

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[9] This Semiotic Hierarchy, which consists of five levels, aims both to differentiate and to connect different kinds of meaning in a unified cognitive-semiotic framework in phenomenological terms (Zlatev 2018: 1).

only perceives the other, but also does so not in neutrality, but with readiness of action (Zlatev 2018: 9). As Abram (1996: 59) argues, perception in the subject involves the experience of an active interplay, or coupling, between the perceiving body and that which it perceives.

Finally, reflective (or explicit) self-consciousness results from an act of reflection, in which the body image plays a pivotal role. Being the aspect allowing for the transition from pre-reflective to reflective self-consciousness, the body image unifies proprioceptive and visual experience of one's own body, by virtue of which the subject of experience can deliberately reflect upon their corporeality, in terms of both physical (anatomic) configuration and position in space. A fully-fledged form of body image constitutes an intentional object of consciousness involving perceptions, attitudes, and beliefs pertaining to our own bodies (Gallagher 2005: 24).

Relocating the Mimic Octopus on the Mimesis Hierarchy

By combining all of the theoretical principles and analytic tools outlined above, we can now raise and painstakingly explain the hypothesis that *T. mimicus* engages in partial imitation of a sea-snake not as a pre-conscious response to a threatening damselfish, but as a response to this threat grounded in a *primitive* form of reflective self-awareness. *Ex*plicit evidence of pre-reflective consciousness in the mimic octopus cannot be provided because this study only draws on observation of an individual that cannot communicate implicit, intrinsic features of its primary experience, such as bodily sensations of fear and stress as well as spatial visual sensations. These sensations run deeper than and come before reflective consciousness, so the moment they are referred to, they automatically shift from pre-reflective to reflective materials. From a phenomenological point of view, pre-reflective consciousness is about non-inferential experience, about *epistemic asymmetry* (e.g. incapacity to *literally* perceive the same object or feel the same pain as the other). Therefore, explicit observation of its existence is not possible, even more so when dealing not with humans, who can at least report on their feelings and sensations through verbal description and gestures, but with an octopus, which undoubtedly cannot. However, because pre-reflective consciousness is a *pre*-requisite for (and *pre*-figures) reflective consciousness, the former can be taken for granted when having access to and accounting for the latter.

Being primitive/rudimentary, reflective self-awareness in the mimic octopus does not obviously relate to attitudes and judgments about beliefs and desires, but it does enable the octopus to consciously map its body with the surrounding physical medium in its spatial experience. In what follows in this subsection, the thought-provoking implications that this putative capacity carries are addressed. Again, it should be pointed out that the suggestions presented below are mostly tentative, based on the observation of live footage of a mimic octopus in action and on cephalopod experts' scientific field and lab findings on (interactional) octopus behaviour.

In our cognitive-semiotic characterisation of *T. mimicus*, we suggest that a change from a complete to a partial imitation model of a banded sea-snake in https://www.youtube.com/watch?v=H8oQBYw6xxc is couched in the octopus' body-awareness (a primitive form of self-consciousness) and its capacity to differentiate itself from the other. This cognitive outfit allows the mimic octopus to appraise and interact with its close landscape as follows:

> "Being out of the den, *I* am — *my* full body is — being seen by an enemy, which detracts from the deceptive effect of a fully deployed mimicry model".

Therefore, for effort-saving purposes, the octopus opts to only mimic the anterior section of a sea-snake body by using one single arm. This pay-off option in turn stands to perceptual reasoning as part of a spatial perspective-taking strategy: as Fig. 3 in Subsection 2.2. shows, the location of the damselfish with respect to the octopus provides the former with a somewhat impoverished field of vision, in which the posterior fragment of the sea-snake is screened by the octopus' head. Accordingly, *T. mimicus*' appraisal of the situation is as follows:

> "There is no reason for me to build up the complete imitation model by linking two of my arms up because my head is standing in the way, partially blocking the damselfish' sight of my moving arms. Consequently, only the arm being seen by the damselfish should be playing the sea-snake body".

Thus deception in this case is grounded in the following aspects: (i) body-awareness — a sense of a core self —, in which the octopus feels its body to be its own and under volitional control to accommodate its limbs and the associated imitation patterns to the situational factors; (ii) cognitive empathy, which involves the differentiation between the subject (the octopus) and object (the damselfish), where the subject is thought to use perspective-taking processes to imagine or project into the object's place (Preston and de Waal 2002: 18). This also conditions the type of imitation.

It is true that body self-awareness remains a controversial issue in studies of (evolutionary) developmental animal psychology and cognition. Nevertheless, our hypothesis finds support in accumulative evidence from experimental research, which demonstrates that octopuses have such complex outer-world knowledge as global workspace, that they *are aware of their position both within themselves and in larger space* (Baars 1997; Mather 2008: 37). Therefore, octopuses are claimed to have observational access to themselves and to the other selves. Having spatial memory, octopuses do know when they are in the wild or in a laboratory tank: their behaviours are vastly affected by their awareness of freedom and captivity, a sense that even many fish species lack (Godfrey-Smith 2016: 46). In the same vein, *T. mimicus*' deceptive behaviour is dramatically affected by its being refle*c*tively conscious that it is not inside its den and that it is being seen by its antagonist. Together with spatial empathy, these circumstances have a crucial bearing on the type of sea-snake imitation taken.

The mimic octopus' adaptive deception act one-steps *pre*determined coordination of perception and action (Mitchell's second level) since it requires conscious spatial and bodily experience. We are thus departing from the reductionist assumption that *T. mimicus* is mechanically programmed to do *p* given that *q* is the case. We are abandoning the view that a dramatic modification of the mimicry programme is caused by pure instinct, according to which deprived of a refuge (den) providing protection, the greater the threat and lower the reaction time to escape are (*q*), the poorer the mimicry model (*p*).

By assuming *T. mimicus* to firstly have body-awareness as a basic form of reflective self-awareness, and secondly, cognitive empathy, we are placing this animal on the dyadic mimetic level of Zlatev's the Mimesis Hierarchy, where these two semiotic structures come into being. On this supposition, *T. mimicus* has a *body image*, which is a more advanced form than the body schema. Body image is a state of being in the world that is accessible to consciousness (Zlatev 2008: 223) through sentient self-body recognition and bodily *inter*action with the surroundings. Therefore, the mimic octopus in https://www.youtube.com/watch?v=H8oQBYw6xxc can be suggested to have an *inter*subjective experience, in which it is *intentionally* performing a partial imitation model,[10] based on its conscious appraisal of the stimulus position with respect to the its own placement. *T. mimicus* carries out a volitional *re*-enactment of the imitation model.

This mimicry pattern modification is sanctioned by the mimic octopus' capacity to discriminate sea-snake body parts and activate or deactivate them intentionally on deceptive display. In other words, *T. mimicus* exploits a feature of perceptual consciousness, Gestalt structure, which enables this cephalopod to bring specific sea-snake body parts to the front (figure) and put the rest of body parts to the back (background) during the deception act. Perceptual consciousness is a semiotic capacity belonging to proto-mimesis, where the body schema operates. Therefore, the body schema underlying visual consciousness in *T. mimicus* enables this animal to attain a strikingly close imitation of a banded sea-snake in terms of both physical resemblance and highly precise enactment. According to a rich-interpretation hypothesis, the mimic octopus' body schema tightly interacts and co-works with its body image (body-awareness/self-awareness and cognitive empathy as a derivative ability), which explains the dramatic change from a complete to a partial imitation display.

To reinforce the argument of advanced visual consciousness in *T. mimicus*, a parallelism can be established between octopuses assembling and disassembling content-rich Gestalt mental constructs, such as the image of a sea-snake, and composite physical objects. Indonesian octopuses have been found to separate half-shells that were nested into one another and discarded by humans, and then, assemble them into spheres as portable shelters (Godfrey-Smith 2016: 52–538). To assemble and disassemble a composite object like this and put it to use is very rare in the animal world. Although many animals combine a variety of materials when making, for instance, compound nests, those are never disassembled, carried around, and put back together (Godfrey-Smith 2016: 52–538).

Following a minimal approach, the octopus widens its imitating arm and makes its tip pointier only because of an inevitable physical constraint — specifically, mechanic muscle torsion and stretching —, so that *T. mimicus* can reach out its arm and appropriately direct it to the signal receiver. According to the richer interpretation, the assumption of an inevitable physical constraint[11] is compatible with the view that the mimic octopus consciously makes these physical modifications for closest resemblance to the mimicry model. In other words, to make the imitation more credible (intentionally deceptive), the octopus widens the section of its mimicking arm that goes around its head in the same way as a sea-snake widens the body section going around a rock (Fig. 6).

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[10] Though not communicatively since the act is *not* a form of intentional communication, which is a semiotic process privative of triadic mimesis and higher levels. Based on past experience, the octopus is aware that its imitation is effective, but it does not understand the act as a deceptive *sign*.

[11] At the end of the day, mechanic torsion and limb stretching unavoidably affect all animals' elongated body parts that are articulated by muscles.

Fig. 6 Widened middle section of a sea-snake's body going around a rock

For further justification of this argument, the regular width of an unstrained sea-snake body is significantly smaller (see Fig. 7) than that of a snake turning the *corner*. This visually perceived anatomic difference is, first and foremost, an aspect of perceptual consciousness, and thus, it does not necessarily involve conscious performance in the sense of *intentional* (dyadic mimetic capacity); however, on the supposition that *T. mimicus* has (reflective) consciousness of its own body and the others' bodies, it does seem justifiable to suggest that body-awareness in the mimic octopus helps this animal

Fig. 7 Unwidened, unstrained body of a sea-snake advancing on the seabed

bring its perceptual consciousness to full potential for an upgraded imitation of the sea-snake.

All of the visual capacities described above indicate that *T. mimicus* engages in complex meaning making at the level of perceptual organisation. More specifically, the mimic octopus is able to cognitively discriminate, and subsequently, integrate different visual input sources (colour differentiation, shape types, levels of thickness, separateness-linkage discrimination, movement patterns). This capacity is known as *perceptual categorisation*, which is one of the prerequisites of consciousness, together with other skills, such as selective attention and learning (Edelman et al. 2005: 170). Perceptual categorisation in this case might allow the mimic octopus to form a simple though precise *concept* of a banded sea-snake. This suggestion finds support in experimental field research that concludes that octopuses have the capacity to form simple concepts as the result of visual and tactile learning (Mather 2008: 37).

Further evidence for impressively developed perceptual consciousness in octopuses is accurate physical recognition. Based on experimental research, Anderson et al. (2010) confirm that captive giant Pacific octopuses in the species *Enteroctopus dofleini* can recognise individual humans, discriminating familiar from unfamiliar. They can do this even when the humans involved in the experiment are wearing identical uniforms. Evidence for this claim is based on changes in the octopuses' body pattern (dark eyebar), behaviours (reaching arms toward or away from the tester and funnel direction) and physiology (respiration rate). Many mammals and birds can recognise individual humans, but the generality of human recognition abilities in invertebrates had been unclear (Anderson et al. 2010: 261).

To strengthen the value of a partial sea-snake imitation model, emphasis should be made on the fact that the visual materials available (live footage and pictures) show *T. mimicus* only displaying a complete or nearly complete version. Figure 8, an image capture from a BBC documentary,[12] is an example of a nearly complete version. As can be seen, the octopus attaches and deploys two tentacles in visible place on the sand to resemble the body of sea-snake; in this case, however, neither of the individual's two tentacle tips takes on the shape of a snake head nor includes a black dot for an eye. This underdeveloped version should not arouse speculations about any forms of (self-)consciousness since explicit markers of this type of mentality are missing.

Given that *T. mimicus* (at least, the specimen examined in the video and analysed in this study) seems to show semiotic structures and processes belonging to the dyadic mimetic level, we suggest that *mimic octopus*, the common name of *Thaumoctopus mimicus*, could be replaced by *mimetic octopus*. Table 4 contains a semiotic classification of non-human deceptive act types from a pre-mimetic through a proto-mimetic to a dyadic mimetic level, based on the argumentation developed throughout this article. The semiotic structures and processes, markers and behaviours, as well as animal examples associated to each meaning-making level are included on the table.

It should be reminded that at this stage of the research, the relocation of *T. mimicus* from the proto-mimetic to the dyadic mimetic level needs further field

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[12] BBC Animal People - Octopus Hunter (The "Mimic" Octopus) (Narrated by D. Attenborough) (1999).

Fig. 8 Nearly complete sea-snake impersonation

and lab investigation, so that it can definitely shift from a hypothesis to a factual assumption. Testing mirror self-recognition, one characteristic marker of the dyadic-mimetic level, should be part of this investigation. Self-recognition has not been included in the table because there are as yet no research results indicating, suggesting or ruling out the existence of this marker in *T. mimicus*.

Conclusions

Drawing on live underwater footage examination of an individual in the octopus species *Thaumoctopus mimicus* — known as *mimic octopus* by the scientific community —, this article reports on an uncommon partial imitation version of a banded sea-snake (*Laticauda* sp.) that is carried out by *T. mimicus* to scare a damselfish away. This unusual partial version clearly departs from the standard (habitual) complete imitation type. Both mimicry models, however, are used facultatively: *T. mimicus* only mimics a sea-snake when encountered by a damselfish.

Detailed observational analysis of the situational factors (den and antagonist location and proximity to the cephalopod) as well as the octopus' body posture, arm shaping and movements while performing the partial impersonation prompts a minimal and a rich interpretation. According to the minimal one, *T. mimicus*' adapted response to the threat is but an irreflective, purely instinctive adaptation for survival, which places this animal at Mitchell's (1986) second level of deceptive acts and at the proto-mimetic level on Zlatev's (2008) Mimesis Hierarchy. According to the rich explanation, the mimic octopus seems to be equipped with cognitive-semiotic skills that would upgrade it to the dyadic mimetic level on Zlatev's Mimesis Hierarchy. Specifically, we raise the possibility that *T. mimicus* has bodily self-awareness (a sense of a core self by virtue of which the octopus feels its body (parts) to be its own and is aware of its position in space) and cognitive empathy (the capacity to use perspective-taking processes to imagine or project into the place of the other).

These skills, together with sound perceptual consciousness that allows this octopus to very closely resemble the physical appearance of a banded sea-snake, suggest that *T. mimicus* has a basic form of body image. Having a primitive form of body image entails having sentient self-body recognition and *intentional* bodily *inter*action with the surroundings. On this basis, the partial sea-snake imitation is

Table 4 Semiotic classification of non-human deceptive acts from a pre-mimetic through a proto-mimetic to a dyadic mimetic level

Levels	Semiotic structures and processes	Markers, behaviours, evidence	Examples
Pre-mimetic level	- Operative intentionality - Basic sense-making - Pre-consciousness - Designed deception - Innate motor schemas	- Habitation - Fixed response patterns	Pigmy sea horse
Proto-mimetic level	- Body schema - Perceptual consciousness - Receiver-sensitive deception - Flexible but still pre-given imitation schemas - Perceptual consciousness	- Mutual attention - Flexible but limited number of models - Degrees of impersonation (not necessarily driven by conscious thinking)	Chameleon
Dyadic mimetic level	- Body image - Basic/primitive reflective consciousness - Self-awareness as “me” - Cognitive empathy	- Volitional control - Imitation learning - Novel imitation models (based on reflective reasoning) - Awareness of the perspective of the other (projection)	Mimetic octopus

The mi*met*ic octopus is included on the dyadic level meant by the octopus to be intentionally deceptive, that is, the mimic octopus reflec*t*ively — not refle*x*ively — takes on a specific imitation format to consciously deceive its enemy more effectively. Following Zlatev's (2018) Semiotic Hierarchy, *T. mimicus* can be argued to be *reflectively conscious* about its deceptive act. For this reason, we suggest that the name *mimic octopus* could be replaced by *mimetic octopus*.

The hypothesis above requires further observational evidence as well as experimental field and lab testing. It also remains a challenge to determine whether the partial imitation model exhibited by *T. mimicus* on https://www.youtube.com/watch?v=H8oQBYw6xxc is a (one-off) discriminatory behaviour by one specific specimen or is the patterning applicable to and recurrent in other individuals in the same species. Meeting these challenges is crucial to gaining valuable empirical insights into the capacity for adapted mimicry in octopuses through learning, stimulus discrimination and self-body recognition.

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