The Role of Image Schemas and Superior Psychic Faculties in Zoosemiosis

José Manuel Ureña Gómez-Moreno

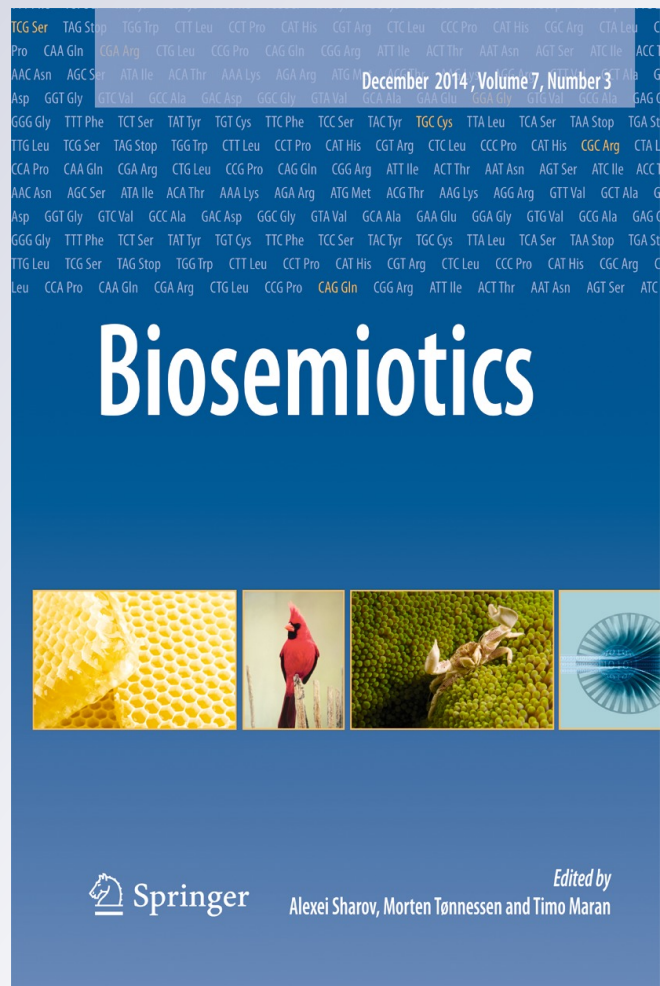Biosemiotics

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Abstract Image schemas are mental constructs central to human cognitive psychology. The neurobiological grounding of these structures has been suggested by experimental research both in non-human primates (Rizzolatti and Craighero 2004; Umiltá et al. 2001) and lower animals (Knudsen 2002, 1998). However, their applicability as concrete cognitive products has not been explored yet in zoosemiotics. This study shows that image schemas are highly instrumental to making sense of the impersonations of two animals featured in biology research studies and wildlife documentary films: the mimic octopus (*Thaumoctopus mimicus*) and the Gibb's sea spider crab (*Pisa armata*). In analysing the movements and postures of these animals, it is argued that image schemas underlie recurring patterns of animal bodily experience and response, which ties image-schematic structures to non-human intersubjectivity. In line with the pluralistic view of zoosemiotics (e.g. Maran, Martinelli and Turovski 2011), this paper takes an intermediary position in the continuity–discontinuity debate regarding communication in humans and animals. In this regard, the complexity of the creative behavioural models of the animals examined leaves the door open for the existence of sophisticated mental life in non-human species.

Keywords Compound image schemas · Impersonation · Interpretive brain · Superior psychic faculties

Introduction

Cognitive ethology assumes a continuity between cognition and communication in humans and other animals. As Griffin (1981: 160) claims, "we need only extend to animals, with suitable modifications, the basic process by which we assess the mental experiences of our own species". This means that zoosemiosis — i.e. intra- and

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interspecific animal communication — may be literally decoded by humans since non-human animals (hereafter animals) have minds, including thought processes, beliefs, rationality, information processing, and consciousness (Bekoff 1999: 371).

In contrast, traditional zoosemiotics, a discipline founded by Sebeok (e.g. 1968; 1972a, b; 1977; 1979a, b; 1990a, b, c) draws on the Peirce's model, i.e. the idea that the basic structure of animal semiosis is a triad of 'sign, object and interpretant' (see Deely 2003 for a thorough account). For zoosemioticians, sign processes, language and consciousness are not located in the mind or the physical carrier's brain, but they are relations (Maran 2010: 324). In other words, the entire phenomenal manifestation of animal communication, what Sebeok (1979a) calls *semiotic self*, is the result of an animal's configuration of signs. Therefore, we cannot speak of an animal mind, which can be studied or proved with the help of scientific methods. Sebeok's stance is in line with the Peircean notion of *abduction*, a process that is neither induction nor deduction, but a "rule of thumb" way of creating a link between inputs and outputs (Barbieri 2009: 27). Abduction, Peirce's logical category, departs from deductive and inductive reasoning in that by abduction we can extrapolate from limited data, successfully *interpret* the world, and build a valid representation of it. In Barbieri's (2013: 43) words, "we are able to 'jump to conclusions' from a limited number of experiences, and in most cases, their 'guesses' turn out to be good enough for survival purposes".

In its most recent developments, zoosemiotics has evolved to a more moderate position, in an attempt to strike a balance between the continuity–discontinuity debate on the cognitive and communicative capabilities of humans and animals (Maran 2010: 327). This new stance, which is enjoying increasing consensus among zoosemioticians (Maran et al. 2011: 14), is known as *the pluralistic approach*. This approach incorporates the Umwelt Theory (von Uexküll 1980), according to which the environment where an organism lives does not only consist in the actual environmental niche, but also in the representation and interpretation that such an organism builds of the niche. The resulting environment is thus "perceivable and meaningful in its entirety only from the perspective of that particular organism" (Martinelli 2010: 26). Importantly, the pluralistic approach involves a consensus for the existence of mental life in animal species (Maran et al. 2011: 14).

The theoretical premises of the pluralistic view of zoosemiotics are applicable to the objectives pursued by this paper. As Sebeok (2001: 124) writes, the semiotic self is a multilayered structure, based on all memory-capable codes in the body including at least immunological, neurological, and cognitive layers. This research gives insights into the cognitive dimension of non-human species. Concretely, the analysis conducted falls into the subcategory of *comparative anthropological zoosemiotics*, which makes comparisons between human and non-human semiosis with a view to establishing potential connections between the two codes (cf. Maran et al. 2011: 9). Specifically, this paper applies the cognitive-semiotic underpinnings of human bodily communication to the movements and postures of two animals featured in documentary films. The methodology of the study exploits the interdisciplinary nature of zoosemiotics, narrowing the gap between human and non-human cognitive psychology through the analysis of image schemas. As Martinelli (2010: 11) highlights, it is safer than before to say that zoosemiotics occupies an intermediary position between natural and human sciences.

The primary goal of this work is to lend support to the pluralistic view of zoosemiotics by demonstrating that human cognitive patterns and constructs are the most effective and natural way to congruently decode and make sense of animal communication. For this purpose, image schemas are shown to be highly instrumental to accounting for both the intermediate stage between a stimulus received by an animal and its behavioural response. In analysing a given animal's response, image schemas are also shown to contribute to the Umwelt Theory, serving as a bridge between an animal's *Innenwelt* and *Umwelt*. The notion of image schema as envisaged in this study should not be mistaken for von Uexküll (1928) notion of schema *(Gestalt)*. As is explained in Section 2, image schemas in the spirit of modern cognitive psychology and linguistics are skeletal, *non*-representational cognitive constructs that underlie content-rich mental images. Despite also having a sensual and functional grounding, Uexküll's *schemata* are something else, evolving from the pure reflection/image of objects *(Objekte)* to the summary of their most important features. Thus, Uexküll's schemata do have a representative function.

At the same time, also in consonance with the pluralistic view of zoosemiotics, this study aims at softening Sebeok's (1979b: 57) assumption that talking about language in other animals beside humans can only be metaphoric (cf. Maran 2010: 321). The reasons why Sebeok's statement ought to be toned down are two: (i) rigorous research reports on neurobiological mechanisms in animals that are argued to have the same image-schematic basis as in humans (see details in Section 2); (ii) the sophisticated imagistic behaviour displayed by the animals examined when impersonating other species are indicative of an anti-reductionist and reflective appraisal of an animal's *Umwelt*. Complex semiotic patterns of this kind depart from pure behaviourism, and provide evidence of superior psychic faculties in non-human mental life. As will be explained, superior psychic faculties in animals are one basic premise of what is known as the *Zoosemiotic Canon* (Martinelli 2010: 163) in the pluralistic view of zoosemiotics. Moreover, research on embryology and biological evolution in biosemiotics — a field of inquiry that includes zoosemiotics (Maran 2010: 327) — also acknowledges a higher degree of complex abstraction in certain animals, resulting from an advanced modelling system of the brain. This system enabled brains to make the leap from instinctive to interpretive biological structures (Barbieri 2013).

Image Schemas as Analytical Tools

Image schemas are fundamental constructs of human cognitive psychology and (applied) cognitive linguistics. There is broad agreement among cognitive linguists and psychologists that an image schema is "a recurring dynamic pattern of our perceptual interactions and motor programs that gives coherence and structure to our experience" (Johnson 1987: xiv). This general description of image schemas has been used, for instance, in the analysis of the phenomenology of every-day experience (Johnson 1987), in the cross-linguistic study of concepts of motion and spatial relations (Dodge and Lakoff 2005), and in the examination of medical pictures to explore the depiction of image-schematic concepts for their verbal and visual representation (Prieto-Velasco and Tercedor-Sánchez 2014). Since Johnson (1987) and Lakoff's (1987) original inventory of image schemas, a variety of open lists has been proposed

in the literature (cf. Hampe 2005: 2 for standard lists), ranging from extensively used schemas, such as CONTAINER and PATH/SOURCE-PATH-GOAL, to less exploited ones, such as DIVERSION and SPLITTING.

The neurobiological and cognitive psychological reality of image schemas has been documented in a significant number of psycholinguistic and empirical neurocognitive studies (e.g. Dodge and Lakoff 2005; Rohrer 2005; Gibbs and Colston 2006). There are various approaches to image schemas, based on different interpretations of criteria, such as their relational character, their level of specificity, the role of perceptual information, or their (un)conscious nature (Hampe 2005: 3). At a cognitive level, this study envisages image schemas as nonrepresentational and interactional mental constructs that constantly recur in bodily experience to structure representational (content-rich) thought. It should also be assumed that once acquired from and activated by appropriate environmental stimuli, image schemas are retrieved from long-term memory since they are enduring mental structures (Gibbs 2005: 117).

One crucial condition that needs to be met to define an image schema is embodiment. Because of their embodied nature, image schemas are pre-conceptual not only to lexical concepts, but to any mental products stemming from sensorimotor experience. For this reason, image schemas can be used to account for animal behaviour and interaction from a cognitive (−semiotic) perspective (see studies below). It should be noted that the pre-conceptual and pre-representational nature of image schemas distinguish them from content-rich mental constructs, such as von Uexküll's (1928) schemata, and upper-staged cognitive structures involved in Karmiloff-Smith's (1992) representational redescription. As Knox (2003: 55) argues, image schemas are simply the first stage of representational redescription, a process whereby the brain constantly sorts and classifies sensory information into meaningful conceptual categories. In other words, representational redescription is "a process of repeated recoding of stored information into new formats which eventually results in representations that can become conscious and expressed in language" (Knox 2003: 53). Representantional redescription thus gives rise to the manipulability and flexibility of the human representational system (Karmiloff-Smith 1992: 186), which is more complex than non-human cognition systems. However, like schemata and full-fledged representational redescription constructs, image schemas are recurrent patterns of perception and bodily movement, and thus, they are "a principal key to the way *all* meaning grows from bodily experience" (Johnson 2005: 29, my emphasis). In this regard, image schemas can be applied to and exploited in non-human cognition.

A considerable number of neuroanatomical experiments have been conducted in non-human primates with revealing outcomes about the neurobiological reality of image schemas in animals. For example, Rizzolatti and Craighero (2004) show how the visual perception of grasping in macaque monkeys is processed by the somatomor cortices, activating the same sensorimotor schemata that would be activated by a monkey grasping something by itself. Umiltá et al. (2001) show that a monkey needs only experience a small portion of the motor movement to complete the entire plan. This finding also illustrates how the principle of the preservation of the bodily topology in the sensorimotor cortices affords the possibility of image-schematic pattern completion at the neural level (Rohrer 2005: 170, 173). Image schemas have also been proposed at the same level in neurobiological experimental studies of more basic animals. For instance, Knudsen (2002) demonstrates that barn owls locate their prey

in space using cross-modal coordination between the auditory and visual perceptual modalities, making it a suitable animal homologue of image schemas. Moreover, cognitive-linguistic research openly advocates for the existence of image-schematic models that define the types of sensorimotor experience in animals (cf. Johnson and Rohrer 2007: 33).

Despite the increasing number of studies of this kind, none of them has systematically broken down the cognitive building blocks of animal movements and postures into image-schemas, understood not as neurophysiological mechanisms, but as concrete nonrepresentational and interactional cognitive constructs of phenomenal experience. In this scenario, the present study shows how the use of image schemas is an exploitable avenue towards the understanding of certain behavioural responses in the animal world. Image schemas are thus presented as the cognitive anchor of non-human intersubjectivity.

Human gestures reveal thought, and thus, are a source of empirical evidence for image schemas (Cienki 2005). Such a finding lays the basis for this research, once shown that there is a correlation between human and non-human embodied cognitive patterns that structure bodily interaction. Also pivotal to this study is the claim that there are image schemas subsidiary to more basic ones. Hierarchies of image schemas and the internal make-up of their relationships have been painstakingly described in studies of verbal input (e.g. Peña 1999, 2003, 2008), but they are yet to be systematically approached in human gestures. Logically enough, this gap extends to non-human bodily communication.

In the remainder of this study, I draw on the theoretical premises of modern zoosemiotics and biosemiotics discussed in the Introduction and Aims sections, and use image schemas as analytical tools in order to make sense of and give insights into particular animal behavioural models. The two case studies presented address interspecific zoosemiotic models. The first case study features the mimic octopus (*Thaumoctopus mimicus*), whereas the second focuses on the Gibb's sea spider crab (*Pisa armata*). These two animals were chosen because they display a wide range of unconventional responses to stimuli in their environment that can readily be explained and interpreted in terms of image-schematic structure. Specifically, *Thaumoctopus mimicus* and *Pisa armata* impersonate a variety of sea organisms, a repertoire which easily lends itself to image-schematic description. As will be shown, the different types of image-schema suggested constitute a valid — and highly productive — analytical method to characterise the mimic octopus and the spider crab's striking behaviours from a cognitive-semiotic perspective. To illustrate each of the mimicry forms of the two animals, this study draws on visual evidence extracted from reliable sources. In the case of the mimic octopus, the materials come from pictures and film clips supplementing a marine biology research study. The visuals of the Gibb's sea spider crab were extracted from a natural history documentary film on aquatic wildlife, which has been broadcast in international TV channels worldwide.

Case Studies

The Mimic Octopus

The mimic octopus (*Thaumoctopus mimicus*) is an Indian Ocean species that has been found to display a repertoire of postures and body patterns, several of which are clearly

impersonations of venomous animals co-occurring in this habitat (Norman et al. 2001): 1755). The film clips at http://rspb.royalsocietypublishing.org/content/268/1478/1755/suppl/DC1[1] illustrate each of the octopus' behavioural models, which all serve the same purpose: to avoid potential predators by mimicry and deception. Since motion cannot be captured in print, figures are given as still images to explain the octopus' behaviour.

Müller's (1998: 110–113) functionalist typology of human gestures can be applied to zoosemiosis. Accordingly, the body postures and movements of *Thaumoctopus mimicus* would be classified as referential gestures in this typology. Referential gestures are defined as depicting entities, attributes of entities — including objects and people —, actions, and behaviours. In this case, the movements (and colour patterns) of the mimic octopus depict other living organisms: a flatfish, a lionfish, and a sea-snake. According to Peirce's (1960) modes of representation, the different impersonations of the mimic octopus would be categorised as icons. In Peirce's (1960: 157, 2.276) words, icons have qualities which resemble those of the objects they represent, and they excite analogous sensations in the mind. The physical form that the sign takes is thus to some degree conditioned by the object or action to which it refers.

Image Schemas

The description of the cognitive capabilities of the Indo-Malayan mimic octopus and the other animal analysed in this study in terms of image schemas is based on the dependency model (Peña 2008). According to this model, image schemas are arranged in hierarchies, based on their basic or subsidiary/dependent nature. Specifically, this paper draws on Peña's (2003: 212–220) typology of image-schematic subsidiarity in order to account for the different kinds of relationships which are established between the image-schemas identified in the research. Peña's three types of subsidiarity are the following: (i) by conceptual dependency; (ii) by logical entailment; and (iii) by enrichment.

Figure 1b shows how *Thaumoctopus mimicus* has drawn all its arms into a leaf-shaped wedge with a central mantle trailing the head in order to imitate the shape of, and thus, look like a flatfish (Fig. 1a). The mimic octopus not only flattens its head, but it also positions its eyes prominently like a flatfish for closer impersonation (Baker 2010: 962). *Thaumoctopus mimicus* mimics a flatfish in colour and in behaviour too as it moves forward by undulating its body and surfacing the sea-floor. This complex mimicry model thus entails the imitation of swim mechanics (posture, style, speed, duration) for deception and colour adaptation for camouflage. Other octopus species, the Atlantic sand-dwelling *Macrotritopus defilippi*, has also been filmed and photographed impersonating a flounder as a primary defence against visual predators (cf. Hanlon, Watson, and Barbosa 2010). As Hanlon et al. (2010: 15) highlight, this is the first documentation of flounder mimicry by an Atlantic octopus, and only the fourth convincing case of mimicry for cephalopods, a taxon renowned for its polyphenism that is implemented not only by neurally controlled skin patterning, but also by their soft flexible bodies.

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[1] These film clips are part of the supplementary data of the research study conducted by Norman, Finn, and Tregenza (2001). This work has been published by the Royal Society's biological research journal *Proceedings B* (see References for full details).
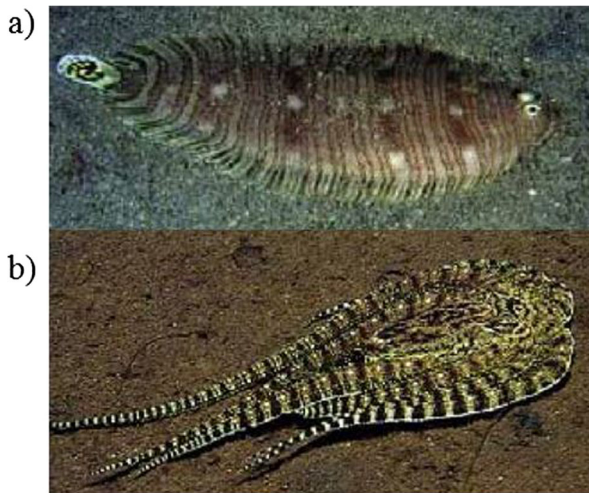
Fig. 1 Flatfish (a) and mimic octopus impersonating it (b) (Norman et al. 2001: 1756)

Let us first focus on the mimic octopus' bodily schema when impersonating a flatfish. Interpreted in terms of image schemas, the ability of the octopus to surface the seafloor so nimbly like a flatfish is a clear example of conceptual dependency. The basic element in the hierarchy is the encompassing FORCE image schema, on which a good number of other subsidiary image schemas depend. Image-schematic structure dependent on FORCE is part and parcel of what Talmy (1988) calls force dynamics. In force dynamics, the bodily logic of image schemas builds upon parameters such as speed of movement, the rhythmic flow of movement, and whether a moving object starts and stops.

In the characterisation of the mimic octopus' impersonation, COMPULSION stands as the most generic image schema on the scale of subsidiarity to FORCE. Concretely, COMPULSION underlies the enactment of *Thaumoctopus mimicus* in the form of *self-instigated motion* — concretely, animate motion (Mandler 1992) — since the octopus, a biological entity, moves with the help of no external agents (Fig. 2a). COMPULSION includes the lower categories RESISTANCE and ATTRACTION. RESISTANCE involves a force that tends to oppose or retard the motion of another entity. This image schema sanctions the sustained upward force exerted by the octopus' muscles in response to gravity. RESISTANCE thus enables the octopus to counteract gravity while swimming very close to the seafloor like a flatfish in order to deceive and avoid potential predators.[2] RESISTANCE should not be mistaken for COUNTERFORCE. In RESISTANCE a moving entity (the octopus) opposes an external kinetic force (gravity), wins out over this kinetic force, and succeeds in keeping moving. In contrast, COUNTERFORCE involves two colliding kinetic entities that are equally strong, and thus, there is no further movement (Fig. 2b). The cognitive scaffolding of gravity is ATTRACTION, which causes the octopus to move down towards the seabed. The interrelation between RESISTANCE and ATTRACTION is given in Fig. 2c. Based on Talmy's (1988: 53) terminology, the octopus'

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[2] This way of swimming is atypical of octopuses, which normally advance across the sea well over the seafloor, or simply, walk on it (see http://www.teara.govt.nz/en/video/7906/octopus-movement).
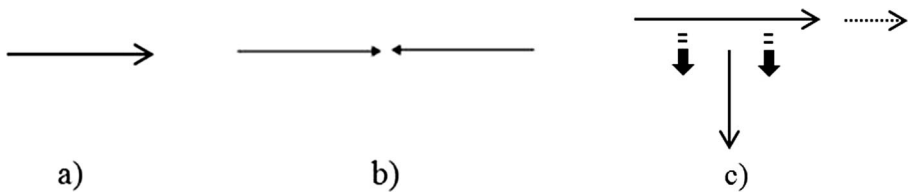
Fig. 2 Self-instigated COMPULSION (a), COUNTERFORCE (b), and RESISTANCE plus ATTRACTION (c)

physical effort is the agonist force, which is singled out for focal attention, whereas gravity is the antagonist force, which opposes the agonist.

In order not to hit the seabed and keep track of its direction as it advances, the octopus needs to encode the visual perception of the topology of its close environment into cognitive patterns. These patterns are SURFACE and PATH, two of the most basic image schemas, which are at work in the octopus' sensorimotor program, together with RESISTANCE and ATTRACTION. SURFACE denotes a two-dimensional, often flat, area and PATH is "the simplest conceptualisation of any object following any trajectory through space, without regard to the characteristics of the object or the details of the trajectory itself" (Mandler 1992: 591). SURFACE and PATH do not belong to the COMPULSION model but to UNBOUNDED REGION, involving an extensive space scope on the scale of bound-edness (see levels in Langacker 1987: 189–197) because the octopus targets an unspecified point in space that is furthest possible to the potential predator identified. SURFACE and PATH enrich and complement RESISTANCE and ATTRACTION in the cognitive structure underlying the mimic octopus' motion. Concretely, we can speak of schematic enrichment since constructs pertaining to different categories interact in mutual feed-back. The close interrelation between RESISTANCE, on the one hand, and SURFACE and PATH, on the other, is further enriched by the STRAIGHT image schema, which has to do with the distinctive recurring pattern of experience of muscular tension and control involved in effortful, non-curvilinear movement of body parts (Cienki 1998). Accord-ingly, in its impersonation, the mimic octopus tenses its muscles to counteract gravity, and traces a non-curvilinear/straight movement as it surfaces the seabed to make its way through the ocean, as a flatfish does.

A zoosemiotic universal — i.e. a transpecific homologous semiotic trait (Martinelli 2011: 266) — met by the mimic octopus is syntax of perception. According to this principle, "all animals perceive the environment as gestalts, i.e. through a top-bottom or, better, figure-background framework" (Martinelli 2011: 267). Syntax of perception has implications for the psychological reality of image schemas in animals. In our case, *Thaumoctopus mimicus* relies on the figure-ground framework when mimicking the colour of a flatfish, which in turn imitates the colour of the sea-floor. More precisely, what the octopus deliberately does is disrupt this framework, so that figure and ground blend and cannot be distinguished anymore. This digital nature of contrast has a correlate in cognitive linguistics and human psychology. In this latter case, the FIG-URE-GROUND schema is responsible for a variety of mental phenomena, such as conceptual metaphor and focal attention, which are reflected on language (cf. Langacker 1987).

In order not to be found by potential predators, the mimic octopus needs not only to change its skin colour, but also to get as close to the seabed surface as possible without

entering into direct contact with it (therefore, the PROXIMALITY — not the CONTACT — schema is activated). Consequently, the figure (the octopus) is mistaken for the ground (seabed). It can thus be argued that the figure-ground model involved in the mimic octopus' behaviour is another example of schematic enrichment because it implies the interplay and close collaboration of cognitive artifacts belonging to different categories. In this case, the figure-ground pattern enriches the SURFACE image schema. Interestingly, this enrichment eventually gives rise to two image schemas: SUPERIMPOSITION and MERGING. Indeed, the mimic octopus volitionally superimposes its own body over the sea-floor, so that the colour patterns of both entities eventually merge to become indistinguishable.

It should be noted that SUPERIMPOSITION is regarded as one type of image schema transformation by Lakoff (1987: 440–444) and Johnson (1987: 26). Image-schematic transformations are operations that involve the ability to manipulate abstract structure in mental space for consequent perceptual interpretation in space. For example, the MUL-TIPLEX-MASS transformation consists of viewing a collection of distinct entities or positions, and then, blurring them into a single, indistinct mass. Similarly, SUPERIMPO-SITION entails zooming in and out between two entities, which, in addition, are superimposed. The mimic octopus clearly exploits this cognitive effect to go unnoticed.

The cluster of image schemas operating in the mimic octopus' cognitive apparatus adds topological structure as one image schema co-ccurs with or follows upon another (schematic enrichment). This systematic cluster is what Kimmel (2005: 289) calls compound image schemas, which typically occur together in a complex experiential gestalt[3] structure that is reducible into simpler gestalts. In his proposal, Kimmel is following Cienki (1997: 9), who argues that "image schemas usually do not occur in an isolated fashion in experience, but rather are experienced grouped as gestalts or wholes". For example, CENTERY-PERIPHERY, NEAR-FAR, SCALE, and FORCE co-occur in the bodily experience of being a centre of force which decreases with distance in a scalar fashion, like when a hand is extended (Cienki 1997: 7–9). In the case of *Thaumoctopus mimicus*, three simpler gestalts, RESISTANCE-ATTRACTION, SURFACE-PATH-STRAIGHT, and PROXIMALITY-SUPERIMPOSITION-MERGING interplay to form a complex gestalt. Based on this complex structure, *Thaumoctopus mimicus* construes a dynamic mental scene in which a movie-clip of sequentially unfolding images of a flatfish helps the octopus closely mimic this fish. As will be argued below, the sophisticated creative mechanism of the mimic octopus lends support to the pluralistic view of zoosemiotics and to current research in biosemiotics, which advocate for superior psychic faculties in animals.

From a semiotic point of view, the mimic octopus' impersonation of a flatfish provides evidence that all three dimensions of zoosemiotics — signification, representation, and communication (Martinelli 2010: 1) — need not necessarily be at work at the same time. First of all, the mimic octopus makes use of physical signification, that is, this animal makes sense out of its environment by mimicry without playing a sender role yet. Secondly, the octopus relies on representation, since it is constructing sense out of a semiotic sign. However, *Thaumoctopus mimicus* will not engage in communication

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[3] In cognitive psychology and linguistics, a gestalt is a whole whose constituents are more easily understood as a holistic structure than as separate individual elements.

(sender-receiver interaction) with any organisms in this case. Far from interacting with potential predators, what the octopus attempts and manages with its behaviour is to go unnoticed. In fact, a flatfish' colour is meant to camouflage the fish against the sea-floor, so the octopus not only behaves in a mimetic but also in a cryptic way.

Figure 3b features the mimic octopus, which has changed the colour of its tentacles to a dark and light brown pattern, and shaped them to look like spines while swimming, thus taking on the appearance and swim mechanics of a lionfish. Lionfish display banded poisonous spines to avoid being attacked (Fig. 3a). The octopus amazingly exploits this mimicry model to scare predators away.[4] This semiotic model displays the gestalts RESISTANCE-ATTRACTION and SURFACE-PATH-STRAIGHT, together with the image schema CENTRE-PERIPHERY (the figure-ground pattern does not apply in this case since the octopus will not try to go unnoticed, but it sends its potential attackers a warning message). Based on the experiential grounding of this image schema, embodied entities (basically, human and non-human animals) draw a twofold distinction between central and peripheral parts. Octopuses normally swim with their eight tentacles exerting no outward force, and thus, trailing behind on the longitudinal axis of their body to gather speed. In contrast, when imitating a lionfish, the mimic octopus tenses and projects the muscles of its tentacles outwards, which necessarily calls upon the distinction between central and peripheral bodily structures. This means that *Thaumoctopus mimicus* widens the scope of perception and experience of its own body by drawing on the CENTRE-PERIPHERY image schema.

Figure 4b shows *Thaumoctopus mimicus*, which has changed the colour pattern of its tentacles to wide black and narrow white stripes. In addition, the octopus moves one tentacle (the left-most tentacle in the picture) in the fashion of a sea-snake. This way, the octopus tricks a damselfish, an extremely territorial animal, into thinking that the tentacle is really a sea-snake (Fig. 4a), a known predator of damselfish. Communication is accomplished through deception and agonist interaction.

Two of the image schemas underlying this behaviour are VERTICALITY and BALANCE. As Fig. 4 shows, the octopus erects one of its tentacles in a prolonged upright position, which requires purposeful, intentional movement and function of a body part that are uncon-ventional in cephalopods. This abnormal body posture entails the octopus' internalisation of vertical topography, which is ultimately anchored in the VERTICALITY image schema. As Rohrer (2005: 173) points out, "image schemas are image-like in that they preserve the topological structure of the whole perceptual experience". The VERTICALITY image schema involves the distinction between the UP and DOWN spatial coordinates. Accordingly, the octopus lifts its tentacle from a DOWN position, keeps it UP, and moves it rhythmically in a patterned way as though it were a sea-snake 'dancing' in a threatening attitude. Rhythmic swinging of a limb on the vertical axis is licensed by the BALANCE image schema, which prevents the tentacle from falling down back to its natural position. In fact, the BALANCE schema depends on how the body controls its muscles in response to a feedback from the nervous system and input from the environment.

The third image schema that contributes to the spatial reasoning of *Thaumoctopus mimicus* is LINKAGE, which is one of the constituents of the image-schematic profile of

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[4] The warning lionfish mimicry model of the mimic octopus has also been found in other Indo-Malayan long-armed octopus, the *Wunderpus photogenicus* n. gen. and sp. (cf. Hochberg, Norman, and Finn 2006).
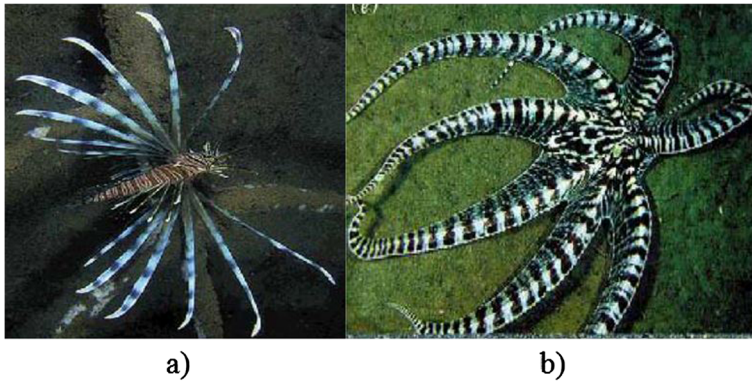
Fig. 3 Lionfish (a) and mimic octopus imitating it (b) (Norman et al. 2001: 1756)

the concept of standing, together with BALANCE, VERTICALITY, CENTER-PERIPHERY, and RESISTANCE (Gibbs 2003: 11). As Peña notes (2008: 1063), whenever the entities that take part in a given state of affairs enter into a relationship of connection between them, the LINKAGE image-schema is at work. Paying closer attention to Fig. 4b, we can see how the octopus has skilfully connected the tentacle dancing upright with another tentacle lying on the sea-floor. The visual effect is a sophisticated imitation of a sea-snake's anterior and posterior body parts, respectively. This way, the whole structure becomes a continuum that looks like the entire elongated body of a sea-snake.
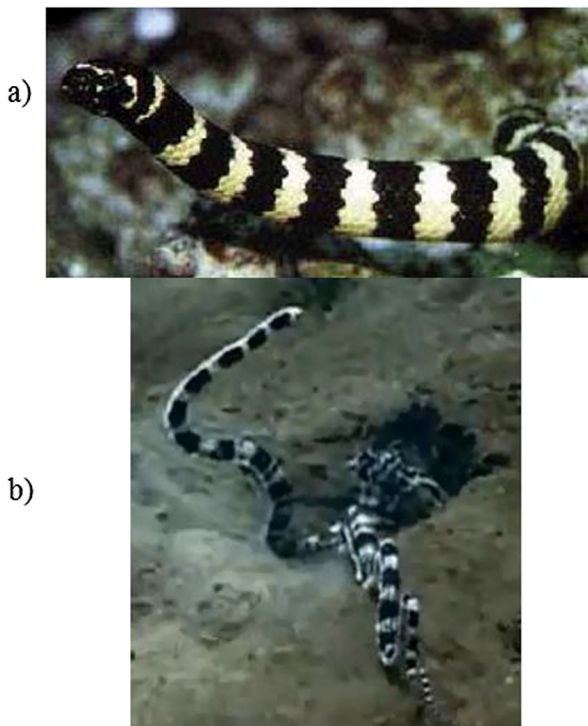

Fig. 4 Banded sea-snake (a) and mimic octopus mimicking it (b) (Norman et al. 2001: 1756)

The fourth image schema operating is CONTAINER, which is one of the very basic schemas, together with PATH and COMPULSION. CONTAINER consists of the primitive gestalt features 'in-out relation', 'boundary', and 'three-dimensionality'. The recognition and cognitive realisation of these space configurations by the octopus' brain enables this animal to conclude that by introducing its body inside a hole on the seabed the damselfish will not notice its presence. This cause-effect sequence, based on the octopus' visual interaction with discrete entities in the world, entails the full-empty pattern, which is a logical entailment of the CONTAINER image schema (Peña 2008: 1043). In other words, the mimic octopus has learnt from experience that filling the hole with its own body implies not being seen by the damselfish. Leaving only two of its tentacles outside the hole calls for the PART-WHOLE image schema, where TENTACLES is the PART and BODY is the WHOLE. PART-WHOLE is subservient to the OBJECT image schema, which also includes CONTAINER to make up a compound image schema, together with VERTICALITY, BALANCE, and LINKAGE. This compound image schema articulates the mimic model of *Thaumoctopus mimicus* as a sea-snake.

Intersubjectivity and Superior Psychic Faculties: the Interpretive Brain

All three complex bodily schemas of the mimic octopus described above provide evidence of the significance of image schemas as prompters of imaginative, and especially, creative thinking in non-human species. As shown by these bodily schemas, creative imagery and its corresponding enactment in the form of mimicry models are a recurrent instrument for meaning-making in animals, and thus, an effective strategy for successful non-human intersubjectivity. In other words, *Thaumoctopus mimicus* conceives its body not simply as an entity in itself, but rather as a complex structure dependent on the impersonation of other bodies as a response for survival. The mimic octopus would not accommodate its body to different postures, movements, and colours if it did not have to interact with other sea organisms for survival. As a consequence of the intersubjective use of its tentacles, for instance, *Thaumoctopus mimicus* can be said to have self- and hetero-perception, two of the zoosemiotic universals proposed by Martinelli (2011: 266–267).

These insights add to the theory of proprioception and exteroception in evolutionary biology (e.g. Trevarthen 2012). According to this theory, an animal's self-appraisal includes awareness of the physical forces of its body parts (proprioception) and awareness of their functions to discriminate goals for adaptive action (exteroception) (Trevarthen 2012: 8–9). In the mimic octopus, these functions emerge from the animal's interpretation and subsequent mimicry of select physical features and behaviour of the salient entities in its landscape.[5] For this purpose, the (bodily postures and movements of) the flatfish, the lionfish, and the sea-snake are decoded by the octopus' brain as situational mental representations, which serve as the intermediary between the landscape and the consequent mimic behaviour. Following Barbieri (2013) in biosemiotics, these mental representations are one type of *brain artifact* (or brain

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[5] *Landscape* should be understood here as envisaged by the theory of landscape ecology (e.g. Farina and Pieretti 2014). According to this theory, a landscape is not only a geographical entity, but also a cognitive medium, i.e. a semiotic context used by organisms to locate resources and interact with intra- and interspecific individuals.

model, following the convention), assembled from brain components according to coding rules. This means that mental images — together with other types of brain model, such as perceptions[6] and emotions — are manufactured artifacts, not spontaneous products of brain processes (Barbieri 2013: 21, 40). Intermediate neurons play a pivotal role in the manufacturing of brain artifacts, providing a bridge between sensory and motor neurons in most animals (Barbieri *ibid.*: 28). On this basis, intermediate neurons can be regarded as the biological grounding of image-schemas, which are cognitive constructs that capture the structural contours of sensory and motor experience to become the skeleton of content-rich mental representations.

In line with studies in biosemiotics, the wide repertoire of mimicry forms of *Thaumoctopus mimicus* as multi-faceted responses to threat reinforces Swan and Goldberg (2013): 298) claim that

> [T]here is no such thing as 'a mind' per se; rather, the term 'mind' acts as a conceptual placeholder for a whole host of abilities […] All living organisms have a host of abilities uniquely attuned to their particular environments.

Moreover, speaking of a standard mind in a standard brain in octopuses would be particularly controversial since three-fifths of an octopus' neurons are not in its brain, but in its arms (Anderson, Mather, and Wood 2010: 10–11).

Astoundingly close impersonations of other sea organisms require a high degree of creative cognitive complexity and subsequent agile enactment, based on extremely accurate somatomotor control. These cognitive-sensorimotor patterns would be typically categorised as instinctive by traditional approaches to zoosemiosis. However, the octopus' bodily mimesis really seems to be beyond the defaults for isolated, purely reductionist semiosis. Particularly thought-provoking is the fact that *Thaumoctopus mimicus* is able to discern which dangerous sea organism to impersonate (a sea-snake) that will present the greatest threat to its current predator or competitor (a damselfish). The tailoring of responses not only to different backgrounds but also to multiple predators has been reported for another group of colour changing organisms, dwarf chameleons (*Bradypodion* spp.) (Stuart-Fox and Moussalli 2009). What makes a difference between a dwarf chameleon and the mimic octopus is that the goal of the former is to avoid observation through a form of facultative crypsis (i.e. camouflage), whereas the goal of the latter is to intelligently intimidate a specific type of predator and scare it away. The model of *Thaumoctopus mimicus* is thus less common than that of the *Bradypodion* species.

The mimic octopus' sophisticated exercise of discernment, which results in careful enactment, is proof of elaborate and reflective non-human cognition. Using Barbieri's (2013: 40) typology, such an evolved ability to interpret the signals from the environment is based on an advanced type of neural processing, which represents the second modelling system of the brain. This system refers to what Barbieri (*ibid.*) calls the interpretive brain, which, for instance, enables some animals to stop chasing a prey when it disappears from sight (like snakes), deduce that the prey has temporarily been

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[6] As Barbieri (2013: 39) highlights, perceptions are distinct from sensations. A sensation is what comes from the senses, and has a specific physiological effect (colour, sound, smell, tickle, and so on). A perception is what the brain decides to do with the information from the senses, according to its own set of processing rules.

hidden by an obstacle and continue chasing it (like mammals), and follow the footsteps of a prey. The first system, which is more primitive, includes the cybernetic and the instinctive brains (the *Innenwelt-Umwelt* tandem). The cybernatic brain carries out totally unconscious processing, simply acting as an intermediary between sense organs and motor organs, whereas the instinctive brain controls purely instinctive — and thus, non-sophisticated — responses (Barbieri 2013: 29). As Barbieri (2013: 30) notes, an instinctive brain "makes decisions on the basis of its own instincts, of its own internal rules, and therefore, has a certain autonomy from the environment", whereas a cybernetic brain "is virtually a puppet in the hands of the environment". Finally, the third modelling system gave rise to language in humans, which is the "last major novelty in brain evolution" (Barbieri 2013: 41).

The antireductionist stance of this paper also draws on research on genetics and animal physiology. For example, zoologists Norman et al. (2001: 1755) show that the dynamic mimicry models of *Thaumoctopus mimicus* avoid the genetic constraints that limit the diversity of genetically polymorphic mimics.

Another stunning response of the mimic octopus to threat involves the combination of two body parts to resemble a sea-snake. Apart from being a perfect example of how to develop awareness of one's body (parts) to full potential, the connection and interplay of tentacles in *Thaumoctopus mimicus* is an evident case of complex creative thinking and enaction with an obvious semiotic purpose. In fact, as Fig. 4b shows, the octopus even imitates the undulating movement of a sea-snake's tail with the tentacle that is lying on the seabed as soon as a damselfish shows up. As explained above, the LINKAGE image schema is crucial since it creates cognitive structure from the spatial structure of a sea-snake and its movement, which results in an elaborate impersonation.

The range of complex behavioural modes of the mimic octopus is sanctioned by animal superior psychic faculties. The acknowledgement of such faculties is the basic premise of the Zoosemiotic Canon. According to this canon, in no case should actions or behaviours be interpreted as the result of an inferior psychic faculty, when it is possible to interpret them as a result of a superior faculty (Martinelli 2010: 169). In the mimic octopus, superior psychic faculties are its intelligent and not extemporaneous creative thinking as well as its adaptive goal-oriented skills, which enable the octopus to switch back and forth between mimicry of different model organisms for survival reasons. This is an ability that has as yet been reported for no animal of any group other than *Thaumoctopus mimicus* (Norman et al. 2001: 1755). As Martinelli (2010: 166) points out, the more adaptive the subject, the more superior its psychic faculties. In other words, creative reasoning in the mimic octopus implies not only the ability to detect threat and respond to it, but also to detect the type of threat and face it in an adaptive manner. This behaviour necessarily draws on consciousness, understood in a way that acknowledges properties, such as behaving like us, as clearly essential, not accidental (Rockwell 2013).

Importantly, claiming for the anti-reductionist nature of the highly sophisticated mimicry models of *Thaumoctopus mimicus* is not at odds with a mechanistic position. Mechanism does not mean reductionism. In fact, as Barbieri (2007: 107) notes, mechanism is quintessentially a non-reductionist approach since a machine is a machine not when it is reduced to pieces, but precisely when it is put together into a functioning whole. The impersonations of the mimic octopus only respond to very specific stimuli and circumstances in its environment. Based on evolutionary

Fig. 5 Fake frontal eyes and green lenses of real upper eyes in the barreleye fish (*FishBase*, global online scholarly fish species database)

psychologist Dennett's (1995: 373) view, this kind of system only works when the environment is regular and predictable enough for the mechanic sub-routines to produce the right result.

One effective way to identify superior psychic faculties behind creative reasoning and consequent impersonation involves contrasting the mimic octopus' mimicry models with modes of imitation that do not require reflective enactment. A good example is the barreleye fish (*Macropinna microstoma*). This species has a pair of olfactory organs above its mouth that look very much like eyes. From a semiotic perspective, these fake eyes help the fish to stay clear from indecisive predators, which are misled to feel watched, and thus, intimidated. Surprisingly, the shape of the fake eyes is sophisticated enough to resemble the eyes of high-order animals, especially humans. In fact, at certain angles the falling of the fake eyelids provides *Macropinna microstoma* with a relaxed, person-like look (see Fig. 5). The greenish roundish structures inside the head of the fish are the lenses of the real eyes, which look upwards, waiting for food to fall.

Unlike the mimic octopus' impersonations, this type of imitation does not build upon conscious imagistic movie-clips of sequentially unfolding images with scenario-like contours. Rather, fake eyes are the result of modifications of some specific genes, which involves a change in the developmental pathways and mechanisms that are engaged in the morphogenesis of the barreleye fish' head. These modifications are independent of the interpretive brain, which results from a more sophisticated type of organic coding (see Barbieri 2013 above). In other words, the fake eyes are not part of a dynamic survival strategy consciously deployed and controlled by *Macropinna microstoma*. In fact, we do not even know whether the barreleye fish is aware of its peculiar anatomic structures.

The Gibb's Sea Spider Crab

The documentary film provided at http://www.rubencasas.com/web/index_en.html [7] features the survival strategy of the Gibb's sea spider crab (*Pisa armata*) in the Majidae family. Again, we will deal with an impersonation with the same semiotic

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[7] This is the website of documentary filmmaker Rubén Casas Oché, who specialises in the filming of aquatic wildlife and marine environments. He took part in the filming of the documentary film *Marenostrum after dark*, where the crab *Pisa Armata* is featured. The documentary film is a *Chello Multicanal and New Atlantis* production, and is free available by clicking on the link *Marenostrum after dark* on the home page. The whole sequence of the Gibb's sea spider can be seen from minute 15:27 to 15:48.

purpose as that of the mimic octopus: to escape predators by deceiving them. This means that the behaviour of *Pisa armata* is another example of iconic gestural sign in interspecific semiosis.

Image Schemas

The Gibb's sea spider crab imitates the gentle movement of an epipelic (attached to the sedimit) alga by swaying at the mercy of the waves to escape the attention of predators. The dorsal carapace surface of this crab not only has dense short, pile-like setae (i.e. bristles) with clusters of larger hook-setae, but it is also invested with massive growths of epizooites, and especially, epiphytes (Kluijver, de M.J et al. 2000). As the video shows, these growths are crucial to reinforce the impersonation. Figure 6 includes four stills of the swaying movement of the crab stuck to the seabed.

   The impersonation of the Gibb's sea spider involves the crab standing up on its posterior legs and projecting its abdominal legs forward and its pincers upwards in a totally unnatural upright posture for a crab. Two image schemas are necessary so that the crab does not lose footing as it is drifted back and forth by the tide: VERTICALITY and BALANCE. Another basic image schema underlying the behaviour of *Pisa armata* is ITERATION, which subsumes CYCLE in the conceptual hierarchy. In its impersonation, the crab traces a curved movement that is iterated until the animal feels that it is no longer under threat. Being more basic, ITERATION is included in Cienki's definition of CYCLE (2005: 431): "A cycle begins, proceeds through a sequence of connected stages, and returns to the original state to start anew". Predators generally identify rectilinear motion as potential prey that is rushing to escape, and pay no attention to curved or deviating slow motions that have no obvious goal. Humans also experience and draw inferences about RECTILINEAR MOTION (Cienki 1998) that are different from those drawn about curved motions with no obvious goal.

   The sensorimotor program of the Gibb's sea spider feeds on one more image schema, ENABLEMENT. Like RESISTANCE, ENABLEMENT is dependent on the force-dynamics schema, and its rationale is as follows: when obstacles are removed, entities are able to move or act in some way or another, which implies absence of restraint. For this reason, ENABLEMENT is not an independent image schema, but a logical entailment of REMOVAL OF RESTRAINT (Peña 2008: 1052). In a normal state of affairs, *Pisa armata* is
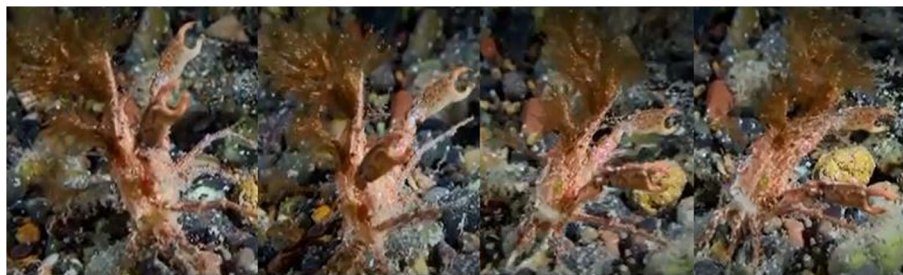

Fig. 6 Four sequences depicting the alga-like appearance and swaying movement of the crab *Pisa armata* (Natural history documentary film, *Chello Multicanal and New Atlantis* production, 2011)

resistant to the tide, and thus, avoids swinging. However, when impersonating an alga, the crab unblocks the resistance — i.e. removes the restraint — of its own body against the swaying force of the tide. This way, the crab is enabled to sway at the mercy of the tide.

The simple gestalts ITERATION-CYCLE and VERTICALITY-BALANCE, together with ENABLEMENT, co-operate to form a complex gestalt or compound image schema. They all structure and give coherence to the quasi-circular movement of *Pisa armata*, which can be broken down into discrete vantage points that undergo change as the crab goes through the different stages in the cycle. Cognitively speaking, dynamic compound schemas are lined up in a scenario-like sequence in the form of a multi-frame clip, in which sizes, relations or vantage points undergo change (Kimmel 2005: 291). It is these sequenced mental representations that enable the crab to imitate an alga so closely. Obviously, such mental images feed on memory, which is necessary to develop high levels of semiotic complexity (Scalambrino 2013: 328). In this case, memory is essential for the Gibb's sea spider to recruit information about the movement of an epipelic alga. Following the pluralistic view of zoosemiotics, the cognitive mechanism of this crab suits the meaning and point of naturalistic explanations.

The compound image schema underlying the behaviour of the Gibb's sea spider is on a par with the image schemas operating when humans, with their feet touching the sea bottom, are gently carried back and forth by the tide close to the shore. As a matter of fact, certain animals are similar to humans in that both can perform mental operations on image schemata that are analogs of spatial operations (Johnson 1987: 25).

Superior Psychic Faculties

Static camouflage is a common strategy in zoosemiosis for different purposes (e.g. the physical appearance of the stonefish enables this animal to go unnoticed and catch prey as they pass by its side). In contrast, imitation of moving organisms, particularly of those that lack volitional motion, is not so common. This latter case includes a sophisticated cognitive exercise because it involves shifting from self-instigated and self-directed to caused movement. Muscle relaxation, letting an external force move one's body, is an unnatural biological pattern in animals with autonomous motor capacities. However, this type of impersonation is relatively easy to find. For instance, some fish species (e.g. the leaf scorpionfish, *Taenianotus triacanthus*) imitate a piece of loose underwater leaf, governed by the force of the tide.

Importantly, the behavioural models of leaf-imitating fish and of the Gibb's sea spider are not entirely alike. The impersonation of *Pisa armata* reveals a still higher degree of abstraction by the interpretive brain since this is not one more example of extemporaneous escape from danger. In fact, the on-line creative enactment of the crab to look and move like an alga is preceded by an all-important off-line strategy, in which this animal exploits the elements in its close landscape. This strategy involves letting epiphyte mats massively grow all over its body as well as purposely sticking algae and other materials, such as bryozoan, hydrozoan and sea particles, onto its carapace in order to strengthen resemblance to an alga (see Fig. 6). This tactic is called *decorating* (Wicksten 1993), and is typical of the spider crab species in the Majidae family. These crabs tear the materials to appropriate size pieces with their chelipeds, and after manipulating them with their mouthparts, attach them to the hooked setae on the dorsal

surfaces of their exoskeleton (Sato and Wada 2000: 705). Otherwise, bare swinging would not be sufficient camouflage to deceive predators. According to the specialist-generalist classification established by crab researchers (e.g. Stachowicz and Hay 2000: 59; Sato and Wada 2000: 713), the impersonation of the Gibb's sea spider crab belongs to the generalist type since this tactic in spider crabs involves "attaching much decoration to themselves in order to blur their outlines and not be recognized by predators as prey" (Sato and Wada 2000: 713). In other words, generalists try to "look less like a crab". In contrast, "the tactic for a specialist is to match the decoration of the crab to the background perfectly. Specialists decorate with a particular algal species […], move to where the colour and texture of their decoration matches the background […] and inhabit the place where those algae are abundant" (Sato and Wada *ibid.*).

The off-stage reasoning of *Pisa armata*, which is grounded in reflective anticipation[8] with an evident semiotic goal, is indicative of prospective problem-solving. As an agent, the spider crab will finally make use of epiphytes and other materials as goal-directed devices of practical activity. Obviously, there are more complex examples of impersonation, as is the case of the mimic octopus. Not surprisingly, the mimicry models of *Thaumoctopus mimicus* also depend on recalling items and situations from the past. However, the whole ritual of the mimic octopus is only performed when there is danger. In other words, the movements and postures of this animal are exclusively made online, on the spot. In contrast, despite being part of a multi-phased imitation program, the preliminary procedure of *Pisa armata* is an off-line, purely prospective strategy prior to impersonation, and thus, another sophisticated way of being imaginatively alive. For this reason, we are dealing with another type of superior psychic faculty, also based on essential — not accidental — properties of a conscious being.

Scholars who would impulsively refer to this phenomenon as instinct could argue that many animal species engage in complex instinctive activities with prospective purposes, such as survival and reproduction. For instance, male bowerbirds are known for their unique courtship behaviour, building a structure and decorating it with sticks and brightly coloured objects in an attempt to attract a mate (prospective goal). Another example is the beaver, which carefully cuts its pieces of wood in such a way that they all weigh the same to build solid dams (Richard 1967). However, as with the Gibb's sea spider, these are unique behaviours that can hardly be based on instinct alone (Martinelli 2010: 165–166). A major reason is that they result from the second modelling system of the brain — not from the first one, which models unconscious response and instinct (Barbieri 2013: 40). Undoubtedly, the fact that *Pisa armata* impersonates another organism is a particularly creative behaviour.

All things considered, my position in the animal language controversy (Maran 2010) between cognitive ethology and zoosemiotics is moderate. Specifically, the assumptions made in this study on impersonation are consistent with the pluralistic view of zoosemiotics insofar as: (i) superior psychic faculties in animals are acknowledged, including sophisticated models of creative agency based on non-self-representing organisms and storage; (ii) consequently, an anti-reductionist view is advocated that argues for an interpretive brain; (iii) we cannot speak of an animal mind per se in the sense of "a mind located in the animal organism", as Maran (2010: 323) cautions, but

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[8] The behaviour of *Pisa armata* provides evidence that one of the most fundamental properties of cognition is its power to predict and anticipate events not only in humans, but also in animals (Trevarthen 2012: 8).

of a conceptual placeholder for a variety of capacities uniquely attuned to the particular environment of each organism. These abilities are couched in image schemas, which are nonrepresentational and interactional mental constructs with a cognitive-structural role in zoosemiosis. My middle position in the continuity–discontinuity debate ties in with Martinelli's (2001: 7) compromise, which we would cautiously suppose to be an emic (versus etic) approach, based on similarity in rules, rituals, structures, and so on. Martinelli (*ibid.*) goes on to highlight that "we are no longer shocked when someone uses the term […] 'reasoning' in reference to animals, and that we should approach animals as if they were an 'early tribal' society quite different from, but in no way inferior to, that of western civilisation".

Potential Metaphoric Thought in Non-Human Species

The bodily postures and movements of the mimic octopus and the Gibb's sea spider as well as the fake eyes of the barreleye fish have not been chosen randomly. Being impersonifications of different animals and body structures, they can be interpreted as visual metaphors from an cognitive-anthropologist perspective. Based on physical and behavioural patterns, these metaphors are sanctioned by conceptual mappings between two domains of experience.[9] Accordingly, the conceptual metaphors A MIMIC OCTOPUS IS A FLATFISH/LIONFISH/SEA-SNAKE and A GIBB'S SEA SPIDER IS AN ALGA can be formulated, where the source domains FLATFISH, LIONFISH, and SEA-SNAKE, on the one hand, and ALGA, on the other, map onto the target domains OCTOPUS and CRAB, respectively. The psycho-cognitive reality of metaphoric mappings in humans has been documented in a number of experimental studies, which demonstrate that people recruit conceptual metaphors, including construction of target and source, when confronted with visual metaphors (e.g. Šorm and Steen 2013).

Reasonably enough, suggesting that superior psychic faculties in animals are anchored in conceptual metaphor is currently too challenging. However, what is unquestionable is that *Thaumoctopus mimicus* and *Pisa armata* understand one entity (their own body) in terms of another (body) for survival purposes. Moreover, once argued that image schemas are structures of general sensorimotor cognition (not specific to human beings), and that some animals have superior psychic faculties, it seems justifiable to test the potential psychological reality of metaphoric thinking in animals by empirical (neuro) pschycological experimentation. If conceptual metaphor existed in non-human cognition, we could gain revealing insights into the interplay between image schemas and conceptual metaphor in the animal world. Research in humans should be taken as a motivating reference. In fact, cognitive metaphor theory and Peirce's semiotics have been shown to share central assumptions about the link between image-schematic conceptual structures, metaphorical projection, and habitual patterns of experience and interpretation (Danaher 1998; Hiraga 1994; Mittelberg 2008).

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[9] Conceptual metaphor, an integral and essential part of human thought processes, consists of understanding and experiencing one kind of thing in terms of another (Lakoff and Johnson 1980: 5). The original and most prolific model of figurative thinking is Conceptual Metaphor Theory (Lakoff and Johnson 1980, 1999; Lakoff 1987, 1993). According to this model, people relate two domains of experience, which are stable cognitive patterns, by means of cross-domain mappings that give rise to conceptual metaphors.

Conclusions

Experimental (Rizzolatti and Craighero 2004; Knudsen 2002, 1998; Umiltá et al. 2001) and theoretical (Johnson 1987; Johnson and Rohrer 2007) research suggests that image schemas are neurobiological structures of general sensorimotor cognition, not specific to human beings. Based on these studies, this work shows that image schemas are valid analytic tools to make sense of animal behaviour and its different semiotic purposes. As cognitive constructs, image schemas structure the cognitive topology of animals, such as the mimic octopus and the Gibb's sea spider, when impersonating other organisms. For this reason, image schemas can be used to gain knowledge of and give coherence to imaginative, and especially, creative animal reasoning in particular semiotic frames. In addition, because of their embodied nature, image schemas help ethologists and cognitive ecologists escape dualisms and cut through metaphysical thickets. Since image schemas are dynamic structures emerging from recurrent patterns of experience, they should encourage behavioural biologists and experts in zoosemiotics to view animal cognition not as a purely abstract and instinctive process, but rather as an experience-based biological phenomenon. In this paper, image schemas are shown to be effective modelling devices. Concretely, they act as organic archetypes that form the foundation for the development of core interpretations and responses of animals to outer stimuli, such as threats and dangers. For future research, the wide repertoire of image schemas could also be used to account for other animal behavioural acts, such as mating, foraging, and territory defence.

This study argues for a highly imagistic power of the impersonations by some animals. Thus, support is lent to the pluralistic view of zoosemiotics, acknowledging superior psychic faculties of non-human cognition and avoiding explanations exclusively based on instinct. In this sense, image schemas are a good argument to mitigate the continuity–discontinuity debate. According to the broader discipline of biosemiotics, the mimic octopus and the Gibb's sea spider crab are claimed to have interpretive brains, which are evolved structures of cybernetic (unconscious) and instinctive brains. Importantly, we should not speak of an animal mind per se, but of a conceptual placeholder for a variety of capacities uniquely attuned to the particular environment of each organism. Consequently, my position in the continuity–discontinuity debate is moderate.

Finally, the wide variety of intelligent impersonations opens the door to a future line of investigation, which would look into the potential psychological reality of conceptual metaphor in animal reasoning, understood as cross-domain mappings triggered by an animal's neural system when exposed to visual input.

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