

Is There Something It's Like to Be a Garden Snail?

Eric Schwitzgebel
Department of Philosophy
University of California at Riverside
Riverside, CA 92521-0201
USA

eschwitz at domain: ucr.edu

October 23, 2018

Is There Something It's Like to Be a Garden Snail?

Abstract: The question “are garden snails phenomenally conscious?” or equivalently “is there something it’s like to be a garden snail?” admits of three possible answers: yes, no, and denial that the question admits of a yes-or-no answer. All three answers have some antecedent plausibility, prior to the application of theories of consciousness. All three answers retain their plausibility also after the application of theories of consciousness. This is because theories of consciousness, when applied to such a different species, are inevitably question-begging and rely partly on dubious extrapolation from the introspections and verbal reports of a single species.

Keywords: consciousness, Cornu aspersum, introspection, Mollusca, phenomenology

Word Count: about 9000 words, plus one photo

Is There Something It's Like to Be a Garden Snail?

1. Introduction.

Is there something it's like to be a garden snail?

I see three possible answers to this question: *yes*, *no*, and **gong**. *The Gong Show* is an amateur talent contest in which performers whose acts are sufficiently horrid are interrupted by a gong and ushered offstage. Not all questions deserve a yes-or-no answer, and this might be one of them – for example if there's an erroneous presupposition behind the question or if the answer is in an indeterminate middle space between yes and no.

When I ask whether there is “something it's like” to be a garden snail, I mean to be invoking Thomas Nagel's usage of the phrase in his famous essay “What Is It Like to Be a Bat?” (1974). Most people in our subculture – that is, highly educated readers of English in the early 21st century – seem happy to assume that there *is* something it's like to be a bat, whereas there's nothing it's like (presumably) to be a stone or a toy robot. In asking whether there's “something it's like” to be a snail, I mean to be asking about what philosophers sometimes call “phenomenal consciousness” or “conscious experience” or the “stream of experience”. I interpret all of these phrases equivalently and, I hope, rather innocently – that is, without intending to assume, in using these phrases, that there is anything non-material or irreducible or intrinsically mysterious going on.

The most effective way to latch onto the intended concept, if you're having trouble with it, is by considering some examples. Consider, for example, your visual experience right now, assuming you have some, or your auditory experience as you stop to listen to the sounds around you. Recall some recent emotional experience you had, of fear or delight or anger, or some inner speech or conscious thoughts or visual imagery which you had, maybe, as you were considering the best way to drive across town during rush hour. These experiences – sensory, imagistic, emotional – all have something important in common:

They're all *experiences*. There's something it was like to have had them. They were parts of your stream of consciousness. In this way, they are different from the growth of your fingernails and the myelination of axons in your brain and your dispositional memories of geographical facts that you aren't thinking about right now. None of the latter are (presumably) conscious. If the term still seems confusing or suspicious to you, I've tried my hand at a more careful definition in Schwitzgebel 2016. If the definition doesn't work, and if, as a result, the question "are garden snails conscious?" doesn't really make sense or pick out a properly defined target (Hacker 2012; Garfield 2015; Frankish 2016; maybe Dennett 1991), of course that is one way of saying *gong*.

The question is important not just because garden snails are important (though they are) but because it is emblematic of a much bigger issue. The bigger issue is how sparse or abundant consciousness is generally, in the universe and on Earth and in your own mind. Under what conditions would a robot be conscious? Or a hypothetical space alien? Are frogs conscious? Earthworms? Crickets? Human fetuses at X weeks? Might social groups give rise to group-level consciousness if there is the right kind of interactivity among the members? How cheap or expensive is it, so to speak, to build a conscious system? The theoretical possibilities run all the way from panpsychism, according to which everything has at least a little smidgen of conscious experience, even elementary particles, to views on which consciousness requires highly sophisticated self-representational capacities well beyond what we could expect of snails and which indeed might only exist in adult human beings in their most reflective moments. I choose snails as my topic because the opinions of both ordinary people and expert researchers seem to be divergent and uncertain. It's fairly radical and unusual to deny consciousness to infants and dogs, though some researchers entertain the idea (Carruthers 2000, forthcoming; Dennett 1996). It is also fairly radical and unusual to embrace panpsychism, though again there are proponents (Strawson 2006; Goff 2017). With

snails, I think, you can kind of get your head around how it might be yes or how it might be no or how, maybe, neither yes nor no might be quite right.

Here's what I'll argue: Yes, no, and *gong* all have some plausibility to them. Any of these answers might be true. Each answer has some antecedent plausibility – some plausibility before we get into the nitty-gritty of detailed theories of consciousness. And if they have some antecedent plausibility, they also have some posterior plausibility – some plausibility *after* we get into the nitty-gritty of theories of consciousness. Antecedent plausibility becomes posterior plausibility due to the presence of a vicious circle. Given the broad range of antecedent plausibilities, to answer the question of how widespread consciousness is, even roughly, we need a good theory. We need, probably, a well-justified general theory of consciousness that we can apply to the case. But a well-justified general theory of consciousness is impossible to build without relying on some background framework assumptions about roughly how widespread consciousness is. Before X we need Y; before Y we need X. Antecedent plausibility becomes posterior plausibility also because theories of consciousness partly rely on introspection or verbal report, and all of our introspections and verbal reports come from a single species, giving us a limited evidence base for extrapolating to very different species.

2. *The Brains and Behavior of Garden Snails.*

If you grew up in a temperate climate, you probably spent some time bothering brown garden snails (*Cornu aspersum*, formerly known as *Helix aspersa*). Their central nervous system contains about 60,000 neurons (Chase, 2001). That's quite a few more neurons than the famously mapped 302 neurons of the *Caenorhabditis elegans* roundworm, but it's also quite a few less than the quarter million of an ant or fruitfly. The garden snail's central nervous system is organized into several clumps of ganglia, mostly in a ring around its

esophagus (Kerkut, Lambert, Gayton, Loke, and Walker 1975). Despite this relatively low number of central nervous system neurons, they have about a quarter million peripheral neurons, mostly in their posterior tentacles, mostly terminating in glomeruli within the tentacles themselves (Chase 2001). Gastropod neurons generally resemble vertebrate neurons, with a few notable differences (Chase 2001, 2002). One difference is that gastropod central nervous system neurons usually don't have a bipolar structure with axons on one side of the cell body and dendrites on the other side. Instead, input and output typically occur on both sides without a clear differentiation between axon and dendrite. Another difference is that although gastropods' small-molecule neural transmitters are the same as in vertebrates (e.g., acetylcholine, serotonin), their larger-molecule neuropeptides are mostly different. Still another difference is that some of their neurons are very large by vertebrate standards.

Snails navigate primarily by chemoreception, or the sense of smell, and mechanoreception, or the sense of touch. They will move toward attractive odors, such as food or mates, and they will withdraw from noxious odors and tactile disturbance. Although garden snails have eyes at the tips of their posterior tentacles, their eyes seem to be sensitive only to light versus dark and the direction of light sources, rather than to the shapes of objects (Chase 2002; Zieger and Meyer-Rochow 2008). The internal structure of snail tentacles shows much more specialization for chemoreception, with the higher-up posterior tentacles perhaps better for catching odors on the wind and the lower anterior tentacles better for taste. Garden snails can also sense the direction of gravity, righting themselves and moving toward higher ground to escape puddles. Arguably, at least some pulmonate snails sleep (Stephenson and Lewis 2011).



Garden snail. Photo: Bryony Pierce (cropped). Used with permission.

Snails can learn. Gastropods fed on a single type of plant will preferentially move toward that same plant type when offered the choice in a Y-shaped maze (Croll and Chase 1980; Avila 1998; relatedly, Nitikin, Korshunova, Zakharov, and Balaban 2008). They can also learn to avoid foods associated with noxious stimuli, sometimes even after a single trial (Sahley, Gelperin, and Rudy 1981; Kimura, Toda, Sekiguchi, and Kirino 1998). Some species will modify their degree of attraction to sunlight if sunlight is associated with tumbling inversion (Crow and Alkon 1978; Lederhendler, Gert, and Alkon 1986). “Second-order” associative learning also appears to be possible: For example, when apple and pear odors are associated and the snails are given the odor of pear but not apple together with the (more delicious) taste of carrot, they will subsequently show more feeding related response to apple odors than will snails for which apple and pear odors were not associated (Lloyd, Fernández, and Acebes 2006; similarly, Hawkins and Byrne 2015). In warm ocean *Aplysia californica* gastropods, the complex role of the central nervous system in governing reflex withdrawals has been extensively studied, partly due to the conveniently large size of *Aplysia*

neurons. *Aplysia californica* reflex withdrawals can be modified centrally -- mediated, inhibited, amplified, and coordinated, maintaining a singleness of action across the body and regulating withdrawal according to circumstances, with both habituation and sensitization possible (Kandel 2001; Chase 2002). Garden snail nervous systems appear to be similarly complex, generating unified action that varies with circumstance.

Garden snails can coordinate their behavior in response to information from more than one modality at once (Adamo and Chase 1991; Chase 2002). As previously mentioned, when they detect that they are surrounded by water, they seek higher ground. They will cease eating when satiated, balance the demands of eating and sex depending on level of starvation and sexual arousal, and exhibit less withdrawal reflex while mating. Land snails will also maintain a home range to which they will return for resting periods or hibernation, rather than simply moving in an unstructured way toward attractive sites or odors (Lind 1989, 1990; Tomiyama 1992; Stringer, Parrish, and Sherley 2018).

Garden snail mating is famously complex (Herzberg and Herzberg 1962; Chase 2002; Koene 2006). The species is a simultaneous hermaphrodite, playing both the male and female role simultaneously. Courtship and copulation requires several hours. Courtship begins with the snails touching heads and posterior tentacles for tens of seconds, then withdrawing and circling to find each other again, often consuming each other's slime trails, or alternatively breaking courtship. They repeat this process several times. During mating, snails sometimes bite each other, then withdraw and reconnect. Later in courtship, one snail will shoot a "love dart" consisting of calcium and mucus at the other, succeeding in penetrating the skin about one third of the time; within some tens of minutes later, the other snail will reciprocate. Successful darts are somewhat damaging to the recipient's skin and sometimes even strike an internal organ. Courtship continues regardless of whether the darts

successfully land. Sex culminates when the partners manage to simultaneously insert their penises into each other, which may require dozens of attempts.

Before egg laying, garden snails use their feet to excavate a shallow cavity in soft soil, then insert their head into the cavity for several hours while they ovulate, then cover the eggs again with soil. This behavior is flexible, varying with soil conditions and disturbance; and in some cases they may even tend their eggs or use other snails' abandoned nests (Basinger 1931; Herzberg and Herzberg 1962; Bailey 2010). Snails normally copulate with several partners before laying eggs, creating sperm competition for the fertilization of their eggs. Eggs are more likely to be fertilized by the sperm of partners whose love darts successfully penetrated the skin during courtship, than by partners whose darts didn't successfully penetrate. The love darts thus appear to function primarily for sperm selection (Chase 2002; Koene 2006).

Impressive accomplishments for creatures with brains of only 60,000 neurons! Of course, snail behavior is limited compared to the larger and more flexible behavioral repertoire of mammals and birds.

*3. The Antecedent Plausibilities of Yes, No, and *Gong*.*

Now, knowing all this... are snails phenomenally conscious? Is there something it's like to be a garden snail? Do snails have, for example, sensory experiences? Suppose you touch the tip of your finger to the tip of a snail's posterior tentacle, and the tentacle retracts. Does the snail have tactile experience of something touching its tentacle, a visual experience of a darkening as your finger approaches and occludes the eye, an olfactory or chematosensory experience of the smell or taste or chemical properties of your finger, a proprioceptive experience of the position of its now-withdrawn tentacle?

3.1. *Yes.* I suspect, though I am not sure, that “yes” is intuitively the most attractive answer for the majority of readers. It seems like we can imagine that snails have sensory experiences, and there’s something a little compelling about that act of imagination. Snails are not passive shrubs, nor simple reflexive responders, but complex explorers of their environment with memories, and sensory integration, centrally-controlled self-regulation in light of sensory input, and cute mating dances. Any specific experience we try to imagine from the snail’s point of view, we will probably imagine too humanocentrically.

Withdrawing a tentacle might not feel much like withdrawing an arm; and with 60,000 central neurons total, presumably there won’t be a wealth of sensory detail in any modality. Optical experience in particular might be so informationally poor that calling it “visual” is already misleading, inviting too much analogy with human vision. Still, I think we can conceive in a general way how a theory of consciousness that includes garden snails among the conscious entities might have some plausibility.

To these intuitive considerations, we can add what I’ll call the *slippery-slope argument* (adapted from Chalmers 1996, p. 293-295).

Most people think that dogs are conscious. Dogs have, at least, sensory experiences and emotional experiences, even if they lack deep thoughts about an abiding self. There’s something it’s like to be a dog. If this seems plausible to you, then think: What kinds of sensory experiences would a dog have? Fairly complex experiences, presumably, matching the dog’s fairly complex ability to react to sensory stimuli. Now, if dogs have rich and complex sensory experiences, it seems unlikely that dogs stand at the lower bound of conscious entities. There must be simpler entities that have simpler experiences.

Similar considerations apply, it seems, to all mammals and birds. If dogs are conscious, it’s hard to resist the thought that mice and ravens are also conscious. And if mice and ravens are conscious, again it seems likely that they have fairly complex sensory

experiences, matching their fairly complex sensory abilities. To think otherwise, one would have to think either that (a.) somewhere in the series from dogs down to mice, consciousness suddenly winks out, or alternatively (b.) that for some range of mammals sensory consciousness becomes radically misaligned with sensory capacities, so that, say, cats have terrific sensory capacities but only a smidgen of sensory consciousness – a very detailed visual perceptual field guiding their bird-chasing through the bushes, for example, but only a little smudge of visual experience. Neither (a) nor (b) seems very attractive.

If this reasoning is correct, we must go lower down the scale of cognitive sophistication to find the lower limits of animal consciousness. If mammals and birds have complex consciousness, who has minimal consciousness? How about lizards, toads, salmon, honeybees? Again, all of them in fact have fairly complex sensory systems, so the argument seems to repeat: If salmon and honeybees have no conscious experiences of any sort, then sensory consciousness must either suddenly wink out at some level of complexity – from the complex sensory experiences of one genus of toad, say, to no experiences at all for a slightly less cognitively sophisticated genus – or alternatively there must be a class of animals with a radical dissociation between their sensory capacities and their sensory experiences, such that complex, detailed sensory capacities in several modalities align with just a smidgen of undetailed consciousness in those modalities.

Where, then, is the lower bound? Chalmers suggests that it might be systems that process a single bit of information, such as thermostats. We ourselves might not want to go as far as Chalmers. However, since garden snails have complex sensory responsiveness, sensory integration, learning, and central nervous system mediation, it seems plausible to suppose that the slippery slope stops somewhere downhill of them.

3.2. *No.* We can also coherently imagine, I think, that garden snails entirely lack sensory experiences of any sort, or any consciousness at all. We can imagine that there's

nothing it's like to be a garden snail. If you have trouble conceiving of this possibility, let me offer you three models.

(a.) *Dreamless sleep.* Many people think (though it is disputed) that we have no experiences at all when we are in dreamless sleep. And yet we have some sensory reactivity. We turn our bodies to get more comfortable, and we process enough auditory, visual, and tactile information that we are ready to wake up if the environment suddenly becomes bright or loud or if something bumps into us. Maybe in a similar way, snails have sensory reactivity without consciousness.

(b.) *Toy robots.* Most people appear to think that toy robots, as they currently exist, have no conscious experiences at all. There's nothing it's like to be a toy robot. There's no real locus of consciousness there, any more than there is in a simple machine like a coffeemaker. And yet toy robots can respond to light and touch. The most sophisticated of them can store "memories", integrate their responses, and respond contingently upon temporary conditions or internal states.

(c.) *The enteric nervous system.* The human digestive system is lined with neurons – about a half a billion of them. These neurons form the enteric nervous system, which helps govern motor function and enzyme release in digestion. The enteric nervous system is capable of operating even when severed from the central nervous system. Despite containing as many neurons as the brain of a small mammal, it's not clear that the enteric nervous system is a locus of consciousness.

You might not like these three models of reactivity without consciousness, but I'm hoping that at least one of them makes enough sense to you that you can imagine how a certain

amount of functional reactivity to stimuli might be possible with no conscious experience at all. I then invite you to consider the possibility that garden snails are like that – no more conscious than a person in dreamless sleep, or a toy robot, or the enteric nervous system.

To support this possibility, consider the following argument, which I'll call the *properties of consciousness argument*. One way to exit the slippery slope argument for “yes” is to insist that sensory capacities aren't enough to give rise to consciousness on their own without some further layer of cognitive sophistication alongside or on top of them. Maybe one needs not only to see but also to be aware *that* one is seeing – that is, to have some sort of meta-representation or self-understanding, some sort of way of keeping track of one's sensory processes. Toads and snails might lack the required meta-cognitive capacities, and thus maybe none of their perceptual processing is conscious.

According to “higher order” theories of consciousness, for example, a mental state or perceptual process is not conscious unless it is accompanied by some (perhaps non-conscious) higher-order representation or perception or thought about the target mental state (e.g., Rosenthal 2005; Gennaro 2012; see also Kriegel 2009 for a related “self-representational” view). Such views are attractive in part, I think, because they so nicely explain two seemingly universal features of consciousness: its luminosity and its subjectivity. By *luminosity* I mean this: Whenever you are conscious it seems that you are aware that you are conscious; consciousness seems to come along with some sort of grasp upon itself. This isn't a matter of reaching an explicit judgment in words or attending vividly to the fact of your consciousness; it's more like a secondary kind of acquaintance with one's own experience as it is happening. (Even a skeptic about the accuracy of introspective report, like me [Schwitzgebel 2011], can grant the prima facie plausibility of this.) By *subjectivity* I mean this: Consciousness seems to involve something like a subjective point of view, some implicit “I” who is the experiencer. This “I” might not extend across a long stretch of time,

or be the robust bearer of every property that makes you “you” – just some sort of sense of a self or of a cognitive perspective. As with luminosity, this sense of subjectivity would normally not be explicitly considered or verbalized; it just kind of tags along, familiar but mostly unremarked.

Now I’m not sure that consciousness is always luminous or subjective in these ways, even in the human case, much less that luminosity and subjectivity are universal features of every conscious species. But still, there’s an attractiveness to the idea. And now it should be clear how to make a case against snail consciousness. If consciousness requires luminosity or subjectivity, then maybe the only creatures capable of consciousness are those who are capable of representing the fact that they are conscious subjects. Maybe this can include chimpanzees and dogs, which are sophisticated social animals and presumably have complex self-representational capacities of at least an implicit, non-linguistic sort. But if the required self-representations are at all sophisticated, then they will be well beyond the capacity of garden snails.

3.3. **Gong**. Maybe we can dodge both the yes and the no. Not all yes-or-no questions deserve a yes-or-no answer. This might be because they build upon a false presupposition (“Have you stopped cheating on your taxes?” asked of someone who has never cheated) or it might be because the case at hand occupies a vague, indeterminate zone that is not usefully classified by means of a discrete yes or no (“Is that a shade of green or not?” of some color in the vague region between green and blue). **Gong** is perhaps an attractive compromise for those who feel pulled between the yes and the no, as well as for those who feel that once we have described the behavior and nervous system of the garden snail, we’re done with the substance of inquiry and there is no real further question of whether snails also have, so to speak, the magic light of consciousness.

Now I myself don't think that there is a false presupposition, and I do think that the question about snail consciousness remains at least tentatively, pretheoretically open even after we have clarified the details of snail behavior and neurophysiology. But I have to acknowledge that my definition of consciousness – basically, pointing to a few synonyms and examples and saying, “get it?” – may not inspire confidence among the skeptically inclined. It is possible that the concept of consciousness I mean to be employing here is incoherent, broken – that there's no real property of the world that we are mutually discussing when we think we are talking about “phenomenal consciousness” or “what it's like” or “the stream of experience”. The most commonly advanced version of this concern holds that the term “consciousness” is irrevocably laden with false suppositions about the features of consciousness – such as its luminosity and subjectivity (as discussed in section 3.2) or its immateriality or irreducibility. Maybe nothing in the world possesses the required suite of features (Feyerabend 1963; Churchland 1983; Garfield 2015; Frankish 2016). “Consciousness” might be a broken concept that fails to refer. Or “consciousness” might be an ambiguous concept: People might simply mean different things by the term, despite attempts at clarification, with the result that seeming disputes about snail consciousness are mostly a matter of people talking past each other.

It is of course possible *both* that people are to some extent talking past each other or employing an objectionably laden concept *and* that a subgroup of interlocutors has converged upon a non-objectionable understanding of phenomenal consciousness. As long as you and I both belong to that subgroup, we can continue this conversation. I will henceforth tentatively assume that we are neither employing a broken concept nor talking past each other.

Alternatively, one might allow that although the *question* “Is X conscious?” makes non-ambiguous sense, it does not admit of a simple yes-or-no answer in the particular case of garden snails. To the question *are snails conscious?* Maybe the answer is neither *yes* nor *no*

but *kind of*. The world doesn't always divide neatly into dichotomous categories. Maybe snail consciousness is a vague, borderline case, like a shade of color might occupy the vague region between green and not-green. (This might fit within a general "gradualist" view about animal consciousness, as maybe in Godfrey-Smith 2017.)

However, despite its promise of an attractive escape from our yes-or-no dilemma, the in-betweenness answer is somewhat difficult to sustain. To see why, it helps to clearly distinguish between being a *little* conscious and being in an indeterminate state between conscious and not-conscious. If one is a little conscious, one is conscious. Maybe snails just have the tiniest smear of consciousness – that would still be consciousness! You might have only a little money. Your entire net worth is a nickel. Still, it is discretely and determinately the case that if you have a nickel, you have some money. If snail consciousness is a nickel to human millionaire consciousness, then snails are conscious.

To say that the dichotomous yes-or-no does not apply to snail consciousness is to say something very different than that snails have just a little smidgen of consciousness. It's to say... well, what exactly? As far as I'm aware, there is no well-developed theory of kind-of-yes-kind-of-no consciousness. We can make sense of vague kind-of-yes-kind-of-no for "green" and for "extravert"; we know more or less what's involved in being a gray-area case of a color or for a personality trait. We can imagine gray-area cases with money too: Your last nickel is on the table over there, and here comes the creditor to collect it. Maybe that's a gray-area case of having money. But it's not obvious how to think about gray-area cases of being somewhere between a little bit conscious and not at all conscious. (See also Antony 2008.)

In the abstract, it is appealing to suspect that consciousness is not a dichotomous property and that garden snails might occupy the blurry in-between region. It's a plausible view that ought to be on our map of antecedent possibilities. However, the view requires

conceiving of a theoretical space – in-between consciousness – that has not yet been well explored.

4. Five Dimensions of Sparseness or Abundance.

The question of garden snail consciousness is, as I said, emblematic of the more general issue of the sparseness or abundance of consciousness in the universe, on Earth, and in your own mind. Let me digress to expand upon this general issue before circling back to garden snails. The question of sparseness or abundance opens up along at least five partly-independent dimensions.

(1.) Consciousness might be sparse in the sense that few entities in the universe possess it, or it might be abundant in the sense that many entities in the universe possess it. Let's call this *entity sparseness* or *entity abundance*. Our question so far has been whether snails are among the entities who possess consciousness. Earlier, I posed similar questions about fetuses, dogs, frogs, worms, robots, group entities, the enteric nervous system, and aliens.

(2.) An entity that is conscious might be conscious all of the time or only once in a while. We might call this *state sparseness* or *state abundance*. Someone who accepts state abundance might think that even when we aren't awake or in REM sleep we have dreams or dreamlike experiences or sensory experiences or at least experiences of some sort. They might think that when we're driving absent-mindedly and can't remember a thing, we don't really blank out completely. In contrast, someone who thinks that consciousness is state sparse would hold that we are often not conscious at all. Consciousness might disappear entirely during long periods of dreamless sleep, or during habitual activity, or during "flow" states of skilled activity. On an extreme state-sparseness view, we might almost never actually be conscious except in rare moments of explicit self-reflection – though we might

not notice this fact because whenever we stop to consider whether we are conscious, that act of reflection creates consciousness where none was before. (This is sometimes called the “refrigerator light error”, after Thomas [1999] who compared it to thinking that the refrigerator light is always on because it’s always on whenever you open the door to check to see if it’s on.)

(3.) Within an entity who is currently state conscious, consciousness might be *modally sparse* or it might be *modally abundant*. Someone who holds that consciousness is modally sparse might hold that people normally have only one or two types of experience at any one time. When your mind was occupied thinking about the meeting, you had no auditory experience of the clock tower bells chiming in the distance and no tactile experience of your feet in your shoes. You might have registered the chiming and the state of your feet non-consciously, possibly even able to remember them if queried a moment later. But it does not follow – not straightaway, not without some theorizing – that such sensory inputs contributed, even in a peripheral way, to your stream of experience before you thought to attend to them. Here again the friend of sparseness can invoke the refrigerator light illusion: Those who are tempted to think that they always experience their feet in their shoes might be misled by the fact that they always experience their feet in their shoes when they think to check whether they are having such an experience. Someone who holds, in contrast, the consciousness is modally abundant will think that people normally have lots of experiences going on at once, though most only at the periphery and quickly forgotten.

(4.) We can also consider *modality width*. Within a modality that is currently conscious in an entity at a time, the stream of experience might be wide or it might be narrow. Suppose you are reading a book and you have visual experience of the page before you. Do you normally only experience the relatively small portion of the page that you are looking directly at? Or do you normally experience the whole page? If you normally

experience the whole page do you also normally visually experience the surrounding environment beyond the page, all the way out to approximately 180 degrees of arc? If you are intently listening to someone talking, do you normally also experience the background noise that you are ignoring? If you have proprioceptive experience of your body as you turn the steering wheel, do you experience not just the position and movement of your arms but also the tilt of your head, the angle of your back, the position of your left foot on the floor? By “width” I mean not only angular width, as in the field of vision, but also something like breadth of field, bandwidth, or richness of information.

(5.) Finally, in an entity at a time within a modality within a band of that modality that is experienced, one might embrace a relatively sparse or abundant view of the *types of properties* that are phenomenally experienced. This question isn’t wholly separable from questions of modality sparseness or abundance (since more types of modality suggests more types of experienced property) or modality width (since more possible properties suggests more information), but it is partly separable. For example, someone with a sparse view of experienced visual properties might say that we visually experience only low-level properties like shape and color and orientation and not high-level properties like being a tree or being an inviting place to sit.

To review this taxonomy: Lots of entities might have conscious experiences, or only a few. Within conscious entities, they might be conscious almost all of the time or only rarely. In those moments of consciousness, they might have many modalities of experience at once or only a few. Within a conscious modality of an entity at a particular moment, there might be wide band of experience or only a narrow band. And within whatever band of experience is conscious in a modality in an entity at a time, there might be a wealth of experienced property types or only a few. All of these issues admit of considerable debate.

Back to our garden snail. We can go entity-sparse and say it has no experiences whatsoever. Or we can crank up the abundance in all five dimensions and say that at every moment of a snail's existence, it has a wealth of tactile, olfactory, visual, proprioceptive, and motivation-related experiences such as satiation, thirst, or sexual arousal, tracking a wide variety of snail-relevant properties. Or we might prefer something in the middle, for a variety of ways of being in the middle.

I draw two lessons for the snail. One is that *yes* is not a simple matter: Within *yes*, there are a variety of possible sub-positions.

The other lesson is this. If you can warm up to the idea that experience might be modality sparse – that people might have some ability to react to things that they don't consciously experience – then that is potentially a path into understanding how it might be the case that snails aren't conscious. If you're not actually phenomenally conscious of the road while you are absent-mindedly driving, well, maybe snail perception is an experiential blank like that. Conversely, if you can warm up to the idea that experience might be modality abundant, that is potentially a path into how it might be the case that snails are conscious. If we have constant tactile experience of our feet in our shoes, despite a lack, maybe, of explicit self-reflection about the matter, maybe consciousness is cheap enough that snails can have it too. Thus, questions about the different dimensions of sparseness or abundance can help illuminate each other.

5. From Antecedent Plausibility to Posterior Plausibility

I have argued that the question “is there something it's like to be a garden snail?” or equivalently “are garden snails conscious?” admits of three possible answers – yes, no, and *gong* – and that each of these answers has some antecedent plausibility. That is, prior to detailed theoretical argument, all three answers should be regarded as viable possibilities

(even if we have a favorite). To settle the question, we need a good theoretical argument that would reasonably convince people who are antecedently attracted to a different view.

It is difficult to see how such an argument could go, for two related reasons: (1.) lack of sufficient theoretical common ground and (2.) the species-specificity of introspective and verbal evidence.

5.1. The Common Ground Problem. Existing theories of consciousness, by leading researchers, range over practically the whole space of possibilities concerning sparseness or abundance – all the way from panpsychism on one end to very restrictive meta-representational views on the other end that deny consciousness even to dogs. The most common (which is not to say the best) arguments against these extreme views illustrate the common ground problem. The most common argument against panpsychism – the reason most people reject it, I suspect – is just that it seems absurd to suppose that protons or simple logic gates could be conscious. We know, we think, prior to our theory-building, that the range of conscious entities does not include protons or simple logic gates. Some of us – including those who become panpsychists – might hold that commitment only lightly, ready to abandon it if presented attractive theoretical arguments to the contrary. However, many of us strongly prefer more moderate views. We feel, not unreasonably, more confident that there is nothing it is like to be a proton than we could ever be that a clever philosophical argument to the contrary was in fact sound. Our Bayesian priors, so to speak, begin in a different place. Thus, we construct and accept our moderate views of consciousness partly from the starting background assumption that consciousness isn't *that* abundant. If a theory looks like it implies proton consciousness, we reject the theory rather than accepting the implication; and no doubt we can find some dubious-enough step in the panpsychist argument if we are motivated to do so.

Similarly, the most common argument against extremely sparse views that deny consciousness to dogs and babies is that it seems absurd to suppose that dogs and babies are not conscious. We know, we think, prior to our theory-building, that the range of conscious entities includes dogs and babies. Some of us might hold that commitment only lightly, ready to abandon it if presented attractive theoretical arguments to the contrary. However, many of us strongly prefer moderate views. We are more confident that there is something it is like to be a dog than we could ever be that a clever philosophical argument to the contrary was in fact sound. Thus, we construct and accept our moderate views of consciousness partly on the starting background assumption that consciousness isn't *that* sparse. If a theory looks like it implies that there's nothing it's like to be a dog, we reject the theory rather than accepting the implication; and no doubt we can find some dubious-enough step in the argument if we are motivated to do so.

In order to develop a general theory of consciousness, one needs to make some initial assumptions about the approximate prevalence of consciousness. Some theories, from the start, will be plainly liberal in their implications about the abundance of consciousness. Others will be plainly conservative. Such theories will rightly be unattractive to people whose initial assumptions are very different; and if those initial assumptions are sufficiently strongly held, theoretical arguments with the type of at-best-moderate force that we normally see in the philosophy and psychology of consciousness will be insufficiently strong to reasonably dislodge those initial assumptions.

If the differences in initial starting assumptions were only moderately sized, there might be enough common ground to overcome those differences after some debate, perhaps in light of empirical evidence that everyone can, or at least should, agree is decisive. However, in the case of theories of consciousness, the starting points are too divergent for this outcome to be likely, barring some radical reorganization of people's thinking about such

matters. Your favorite theory might have many wonderful virtues! People who start from a very different perspective might admire it immensely. They might admire it immensely as a theory of *something else*, not phenomenal consciousness – a theory of information, or a theory of reportability, or a theory of consciousness-with-attention, or a theory of a states with a certain type of cognitive-functional role.

For example, Integrated Information Theory is a lovely theory of consciousness (Oizumi, Albantakis, and Tononi 2014). Well, maybe it has a few problems (Aaronson 2014; Schwitzgebel 2014; Bayne 2018), but it is renowned, and it has a certain elegance. It is also very nearly panpsychist, holding that consciousness is present wherever information is integrated, even in tiny little systems with simple connectivity, like simple logic gates. For a reader who enters the debates about consciousness attracted to the idea that consciousness might be sparsely distributed in the universe, it's hard to imagine any sort of foreseeably attainable evidence that ought rightly to lead them to reject that sparse view in favor of a view so close to panpsychism. They might love IIT, but they could reasonably regard it as a theory of something other than conscious experience – a valuable mathematical measure of information integration, for example.

Or consider a moderate view, articulated by Zohar Bronfman, Simona Ginsburg, and Eva Jablonka (2016). Bronfman and colleagues generate a list of features of consciousness previously identified by consciousness theorists, including “flexible value systems and goals”, “sensory binding leading to the formation of a compound stimulus”, a “representation of [the entity's] body as distinct from the external world, yet embedded in it”, and several other features (p. 2). They then argue that all and only animals with “unlimited associative learning” manifest this suite of features. The gastropod *Aplysia californica*, they say, and presumably related snails and slugs like the garden snail, are not capable of unlimited associative learning because they are incapable of “novel” actions (p. 4). Insects, in contrast,

are capable of unlimited associative learning, Bronfman and colleagues argue, and thus are conscious (p. 7). So there's the line!

It's an intriguing idea. Determining the universal features of consciousness and then looking for a measureable functional relationship that reliably accompanies that set of features – theoretically, I can see how that is a very attractive move. But why *those* features? Perhaps they are universal to the human case (though even that is not clear), but it's doubtful that someone antecedently attracted to a more liberal theory is likely to agree that flexible value systems are necessary for low-grade consciousness. If you like snails... well, why not think they have integration enough, learning enough, flexibility enough? Bronfman and colleagues' criteria are more stipulated than argued for. One might reasonably doubt this starting point, and it's hard to see what later moves can be made that ought to convince someone who is initially attracted to a much more abundant or a much sparser view.

The challenges multiply when we consider Artificial Intelligence systems and possible alien minds, where the options span a considerably wider combinatorial range. AIs and aliens might be great at some things, horrible at others, and structured very differently from anything we have so far seen on Earth. This expands the opportunities for theories with very different starting points to reach divergent judgments that are difficult to reasonably dislodge.

Not all big philosophical disputes are like this. In applied ethics, we start with quite a lot of common ground. Even ancient Confucianism, which is about as culturally distant from the 21st-century West as one can get and still have a large written tradition, shares a lot of moral common ground with us, despite some important differences. It's easy to agree with much of what Confucius says. In epistemology, we agree about a wide range of cases of knowledge and non-knowledge, and good and bad justification, which can serve as shared background for building general consensus positions on which we might agree. Debates

about the abundance or not of consciousness differ from most philosophical debates in having an extremely wide range of reasonable starting positions and little common ground by which theorists near one end of the spectrum can gain non-question-begging leverage against theorists near the other end. (Continuing the comparison with epistemology, the intractability of radical skepticism is an exception that illustrates the rule: If we include radical skeptics among our interlocutors, the common ground problem risks becoming insurmountable.)

5.2. The Species-Specificity of Verbal and Introspective Evidence. The study of consciousness appears to rely, partly, but in an important way, on researchers' or participants' introspections, judgments about their experiences, or verbal reports, which need somehow to be related to physical or functional processes. We know about dream experiences, or inner speech, or visual imagery – or the presence or absence of an experience of unattended phenomena in our perceptual fields – partly because of what people judge or say about their experiences. Despite disagreements about ontology and method, this appears to be broadly accepted among theorists of consciousness (e.g., Dennett 1991; Goldman 1997; Chalmers 2004; Hatfield 2005/2009; Piccinini 2003; Hurlburt 2011; Tsuchiya, Frässle, Wilke, and Lamme 2016; Overgaard 2017). I have argued elsewhere that introspection is a highly unreliable tool for learning about general structural features of consciousness, including the sparseness or abundance of human experience (Schwitzgebel 2011). However, even if we grant a certain amount of achievable consensus about the scope and structure of human consciousness, and how it relates to human brain states and psychological function, inferring beyond our species to very different types of animals involves some serious epistemic risks.

Behavior and physiology are directly observable (or close enough), but the presence or absence of consciousness must normally be inferred – or at least this is so once we move beyond the most familiar cases of intuitive consensus. However, the evidential base grounding such inferences is limited. Introspective and verbal self-report evidence are an

important part of the evidential grounds for theories of consciousness, but all (or virtually all?) of our introspective and verbal evidence comes from a single species. The farther we move away from the familiar human case, the shakier our ground. We have to extrapolate in a risky way, far beyond the scope of our direct introspective and verbal evidence. Perhaps an argument for extrapolation to nearby species (apes? all mammals? all vertebrates?) can be made on grounds of evolutionary continuity and morphological and behavioral similarity – if we are willing (but should we be willing?) to bracket concerns from advocates of entity-sparse views. Extrapolating beyond the familiar cases to snails (or robots, or weirdly structured aliens – especially if they are incapable of interpretable speech) will inevitably be conjectural and uncertain (see also Nagel 1974; Block 2002/2007). The uncertainties involved provide basis for ample reasonable doubt among theorists who are antecedently attracted to very different views.

Let's optimistically suppose that we learn that, in humans, consciousness involves X, Y, and Z physiological or functional features. Now, in snails we see X', Y', and Z', or maybe W and Z''. Are X', Y', and Z', or W and Z'', close enough? Maybe consciousness in humans requires recurrent neural loops of a certain sort (Humphrey 2011; Lamme 2018). Well, snail brains have some recurrent processing too. But of course it doesn't look either entirely like the recurrent processing that we see in the human case when we are conscious, nor entirely like the recurrent processing that we see in the human case when we're not conscious. Or maybe consciousness involves availability to, or presence in, working memory or a "global workspace" (Baars 1988; Dehaene and Changeux 2011; Prinz 2012). Well, information travels broadly through snail brains, enabling coordinated action. Is that global workspace enough? It's like our workspace in some ways, unlike it in others. In the human case, we might be able to – if things go very well! – rely on introspective reports to help ground a theory about how broadly information must be shared within our cognitive system

for that information to be consciously experienced, but it is unclear how we should then generalize such findings to the case of the garden snail.

So we can imagine that the snail is conscious, extrapolating from the human case on grounds of properties we share with the snail; or we can imagine that the snail is not conscious, extrapolating from the human case on grounds of properties we don't share with the snail. Both ways of doing it seem defensible, and we can construct attractive, non-empirically-falsified theories that deliver either conclusion. We can also think, again with some plausibility, that the presence of some relevant properties and the lack of other relevant properties makes it a case where the human concept of consciousness fails to determinately apply.

6. Conclusion.

Maybe we can figure it all out someday. Science can achieve amazing things, given enough time. Who would have thought, a few centuries ago, that we'd have mapped out in such detail the first second of the Big Bang? Our temporal evidential base is very limited; the cosmological possibilities may have initially seemed extremely wide open. We were able to overcome those obstacles. Possibly the same will prove true, in the long run, with consciousness.

Meanwhile, though, I find something wonderful in not knowing. There's something fascinating about the range of possible views, all the way from radical abundance to radical sparseness, each with its merits. There's something marvelous about the fact that I can wander into my backyard, lift a snail, and gaze at it, unsure. Snail, you are a puzzle of the universe in my own garden, eating the daisies!¹

¹ For helpful discussion, thanks to Debbie Alamé-Jones, Kristen Andrews, Ronald Chase, Becko Copenhaver, Joris Koene, Sofia Ortiz; audiences at Washington University in Saint Louis and University of Missouri at Saint Louis; and commenters on relevant posts at

The Splintered Mind and my Facebook page. The analogy between consciousness and money is due to John Searle in conversation, long ago.

References

- Aaronson, Scott (2014). Giulio Tononi and me: A Phi-nal exchange. Blog post at *Shtetl Optimized* (May 30). URL: <https://www.scottaaronson.com/blog/?p=1823> [accessed Jul. 5, 2018].
- Adamo, Shelley A., and Ronald Chase (1991). The interactions of courtship, feeding, and locomotion in the behavioral hierarchy of the snail *Helix aspersa*. *Behavioral and Neural Biology*, 55, 1-18.
- Antony, Michael V. (2009). Are our concepts CONSCIOUS STATE and CONSCIOUS CREATURE vague? *Erkenntnis*, 68, 239-263.
- Aru, Jan, and Talis Bachmann (2013). Phenomenal awareness can emerge without attention. *Frontiers in Human Neuroscience*, 7 (891). doi: 10.3389/fnhum.2013.00891
- Avila, Conxita (1998). Chemotaxis in the nudibranch *Hermisenda crassicornis*: Does ingestive conditioning influence its behavior in a Y-maze? *Journal of Molluscan Studies*, 64, 215-222.
- Baars, Bernard J. (1988). *A cognitive theory of consciousness*. Cambridge: Cambridge.
- Bailey, Elisabeth Tova (2010). *The sound of a wild snail eating*. New York: Workman.
- Basinger, A.J. (1931). *The European brown snail in California*. University of California College of Agriculture Agricultural Experiment Station, Bulletin 515. Berkeley, CA: University of California.
- Bayne, Tim (2018). On the axiomatic foundations of the integrated information theory of consciousness. *Neuroscience of Consciousness*, 4 (1): niy007. doi: 10.1093/nc/niy007
- Block, Ned (2002/2007). The harder problem of consciousness. In N. Block, *Consciousness, function, and representation*. Cambridge, MA: MIT.

- Block Ned (2007). Consciousness, accessibility, and the mesh between psychology and neuroscience. *Behavioral and Brain Sciences*, 30, 481-548.
- Bronfman, Zohar Z., Simona Ginsburg, and Eva Jablonka (2016). The transition to minimal consciousness through the evolution of associative learning. *Frontiers in Psychology*, 7 (1594): doi: 10.3389/fpsyg.2016.01954
- Cabej, Nelson R. (2012). *Epigenetic principles of evolution*. Amsterdam: Elsevier.
- Carruthers, Peter (2000). *Phenomenal consciousness*. Cambridge: Cambridge.
- Carruthers, Peter (forthcoming). The problem of animal consciousness. *Proceedings and Addresses of the American Philosophical Association*.
- Chalmers, David J. (1996). *The conscious mind*. New York: Oxford.
- Chalmers, David J. (2004). *How can we construct a science of consciousness?* Online manuscript at <http://consc.net/papers/scicon.html> [accessed Sep. 26, 2018].
- Chase, Ronald (2002). *Behavior and its neural control in gastropod molluscs*. Oxford: Oxford.
- Churchland, Patricia Smith (1983). Consciousness: The transmutation of a concept. *Pacific Philosophical Quarterly*, 64, 80-95.
- Croll, Roger P. and Ronald Chase (1980). Plasticity of olfactory orientation to foods in the snail *Achatina fulica*. *Journal of Comparative Physiology*, 136, 267-277.
- Crow, Terry J., and Daniel L. Alkon (1978). Retention of an associative behavioral change in *Hermisenda*. *Science*, 201 (4362), 1239-1241.
- Dehaene, Stanislas, and Jean-Pierre Changeux (2011). Experimental and theoretical approaches to conscious processing. *Neuron*, 70, 200-227.
- Dennett, Daniel C. (1991). *Consciousness explained*. Boston: Little, Brown & Co.
- Dennett, Daniel C. (1996). *Kinds of minds*. New York: Basic Books.
- Feyerabend, Paul (1963). Mental events and the brain. *Journal of Philosophy*, 40, 295-296.

- Frankish, Keith (2016). Illusionism as a theory of consciousness. *Journal of Consciousness Studies*, 23 (11-12), 11-39.
- Garfield, Jay L. (2015). *Engaging Buddhism*. Oxford: Oxford.
- Gennaro, Rocco J. (2012). *The consciousness paradox*. Cambridge, MA: MIT.
- Godfrey-Smith, Peter (2017). The evolution of consciousness in phylogenetic context. In K. Andrews and J. Beck, *The Routledge Handbook of Animals Minds*. New York: Routledge.
- Goff, Philip (2017). *Consciousness and fundamental reality*. New York: Oxford.
- Goldman, Alvin I. (1997). Science, publicity, and consciousness. *Philosophy of Science*, 64, 525-545.
- Hacker, P.M.S. (2012). The sad and sorry history of consciousness: Being, among other things, a challenge to the “consciousness studies” community. *Royal Institute of Philosophy Supplement*, 70, 149-168.
- Hatfield, Gary (2005/2009). Introspective evidence in psychology. In G. Hatfield, *Perception and Cognition*. Oxford: Oxford.
- Hawkins, Robert D., and John H. Byrne (2015). Associative learning in invertebrates. *Cold Spring Harbor Perspectives in Biology*. doi: 10.1101/cshperspect.a021709
- Herzberg, Fred, and Anne Herzberg (1962). Observations on reproduction in *Helix aspersa*. *American Midland Naturalist*, 68, 297-306.
- Humphrey, Nicholas (2011). *Soul dust*. Princeton: Princeton.
- Hurlburt, Russell T. (2011). *Investigating pristine inner experience*. Cambridge: Cambridge.
- Irvine, Elizabeth (2013). *Consciousness as a scientific concept*. Dordrecht: Springer.
- Jennings, Carolyn Dicey (2015). Consciousness without attention. *Journal of the American Philosophical Association*, 1, 276-295.

- Kandel, Eric R. (2001). The molecular biology of memory storage: a dialogue between genes and synapses. *Science*, 294 (5544). 1030-1038.
- Kerkut, G.A., J.D.C. Lambert, R.J. Gayton, Janet E. Loker, and R.J. Walker (1975). Mapping of nerve cells in the subesophageal ganglia of *Helix aspersa*. *Comparative Biochemistry and Physiology Part A: Physiology*, 50 (1), 1-25.
- Kimura, Tetsuya, Shoichi Toda, Tatsuhiko Sekiguchi, and Yutaka Kirino (1998). Behavioral modulation induced by food odor aversive conditioning and its influence on the olfactory responses of an oscillatory grain network in the slug *Limax marginatus*. *Learning and Memory*, 4, 365-375.
- Koene, Joris M. (2006). Tales of two snails: Sexual selection and sexual conflict in *Lymnaea stagnalis* and *Helix aspersa*. *Integrative & Comparative Biology* 46, 419-429
- Kriegel, Uriah (2009). *Subjective consciousness*. Oxford: Oxford.
- Lamme, Victor A.F. (2018). Challenges for theories of consciousness: seeing or knowing, the missing ingredient and how to deal with panpsychism. *Philosophical Transactions of the Royal Society B*, 373: 20170344.
<http://dx.doi.org/10.1098/rstb.2017.0344>
- Lederhendler, I. Izja, Serge Gart and Daniel L. Alkon (1986). Classical conditioning of *Hermisenda*: Origin of a new response. *Journal of Neuroscience*, 6, 1325-1331.
- Lind, Hans (1989). Homing to hibernating sites in *Helix pomatia* involving detailed long-term memory. *Ethology*, 81, 221-234.
- Lind, Hans (1990). Strategies of spatial behavior in *Helix pomatia*. *Ethology*, 86, 1-18.
- Lloyd, Ignacio, Vanesa Fernández, and Félix Acebes (2006). Conditioning of tentacle lowering in the snail (*Helix aspersa*): Acquisition, latent inhibition, overshadowing, second-order conditioning, and sensory preconditioning. *Learning & Behavior*, 34, 305-314.

- Nagel, Thomas (1974). What is it like to be a bat? *Philosophical Review*, 83, 435-450.
- Nikitin, E.S., T.A. Korshunova, I.S. Zakharov, and P.M. Balaban (2008). Olfactory experience modifies the effect of odour on feeding behaviour in a goal-related manner. *Journal of Comparative Physiology A*, 194, 19-26.
- Oizumi, Masafumi, Larissa Albantakis, and Giulio Tononi (2014). Consciousness: Integrated Information Theory 3.0. *PLOS Computational Biology*.
<https://doi.org/10.1371/journal.pcbi.1003588>
- Overgaard, Marten (2017). The status and future of consciousness research. *Frontiers in Psychology*, 8 (1719). DOI: 10.3389/fpsyg.2017.01719
- Piccinini, Gualtiero (2009). First-person data, publicity, and self-measurement. *Philosophers' Imprint*, 9, 1-16.
- Prinz, Jesse J. (2012). *The conscious brain*. Oxford: Oxford.
- Rosenthal, David M. (2005). *Consciousness and mind*. Oxford: Oxford.
- Sahley, Christie, Alan Gelperin, and Jerry W. Rudy (1981). One-trial associative learning modifies food odor preferences of a terrestrial mollusc. *Proceedings of the National Academy of Sciences*, 78, 640-642.
- Schwitzgebel, Eric (2011). *Perplexities of consciousness*. Cambridge, MA: MIT.
- Schwitzgebel, Eric (2014). Tononi's Exclusion Postulate would make consciousness (nearly) irrelevant. Blog post at *The Splintered Mind* (Jul. 16). URL:
<http://schwitzsplinters.blogspot.com/2014/07/tononis-exclusion-postulate-would-make.html> [accessed Sep. 25, 2018].
- Schwitzgebel, Eric (2016). Phenomenal consciousness, defined and defended as innocently as I can manage. *Journal of Consciousness Studies*, 23 (11-12), 224-235.

- Stephenson, Richard, and Vern Lewis (2011). Behavioural evidence for a sleep-like quiescent state in a pulmonate mollusc, *Lymnaea stagnalis* (Linnaeus). *Journal of Experimental Biology*, 214, 747-756
- Strawson, Galen (2006). *Consciousness and its place in nature*, ed. A. Freeman. Exeter, UK: Imprint Academic.
- Stringer, Ian Alexander Noel, Glenn Richard Parrish, and Gregory Howard Sherley (2018). Homing, dispersal and mortality after translocation of long-lived land snails *Placostylus ambagiosus* and *P. hongii* (Gastropoda: Bothriembryontidae) in New Zealand. *Molluscan Research*, 38, 56-76,
- Thomas, Nigel J.T. (1999). Are theory of imagery theories of imagination? An active perception approach to conscious mental content. *Cognitive Science*, 23, 207-245.
- Tomiya, Kiyonori (1992). Homing behaviour of the giant African snail, *Achatina fulica* (Ferussac) (Gastropoda; Pulmonata). *Journal of Ethology*, 10, 139-146.
- Tsuchiya, Naotsugu, Stefan Frässle, Melanie Wilke, and Victor Lamme. (2016). No-report and report-based paradigms jointly unravel the NCC: response to Overgaard and Fazekas. *Trends in Cognitive Sciences*, 20, 242-243.
- Zieger, Marina V. and Victor Benno Meyer-Rochow (2008). Understanding the cephalic eyes of pulmonate gastropods: A review. *American Malacological Bulletin*, 26 (1-2), 47-66.