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Becoming aware: Towards a post-constructivist theory of learning

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Abstract

The dominant learning paradigms conceive of learning as the construction of something, which, depending on the particular bent of the researcher, may be “meaning,” “knowledge,” “conceptions,” or “conceptual frameworks.” However, some recent studies conducted from very different theoretical perspectives showed that students cannot intentionally orient towards what is to be known after a curricular event precisely because the object that directs such an orientation (e.g., future knowledge) does not yet exist. The purpose of this study is to describe and theorize the phenomenon of *becoming aware* and to suggest the underlying movement as a more appropriate unit of learning. Epistemological, methodological, and instructional implications are discussed.

Keywords aspect dawning; phenomenology; epistemology; first-person investigation; cognition; learning

Between the 1960s and 1980s, there was a lively debate about the appropriate epistemology to be taken when studying student learning. Behaviorism, Piaget’s stage theory, information processing, neo-Piagetian theories combining stage theory with information processing, and conceptual change all were part of a panoply of theoretical tools available to the learning scientist. Since then, however, constructivism, in its various forms, has risen to become a master theory. Yet there are many different forms of experiences that cannot be explained using a constructivist approach—especially the different forms of experiences that have to do with the human capacity to be affected and suffer: passibility. With respect to learning, the inherent unavailability of the future and the openness of a happening that becomes a definite event only after the fact, make it impossible for students to construct knowledge in the way that this verb implies. The verb *to construct* is a poor theoretical choice because it is *transitive* (i.e., requiring subject and object) and because—as theorized by means of the object/motive concept of cultural-historical activity theory, which implies knowledge of the activity-orienting motive—we inherently cannot know the object of future knowledge that is only revealed to us as a consequence and end product of learning. The unsuitability of this verb and the associated epistemology has already been exhibited in a pragmatic approach to language philosophy. Thus, the

craftsman typically knows what job he needs to do before picking or inventing tools with which to do it. By contrast, someone like Galileo, Yeats, or Hegel (a “poet” in my wide sense of the term—the sense of “one who

makes things new”) is typically unable to make clear exactly what it is that he wants to do before developing the language in which he succeeds in doing it. His new vocabulary makes possible, for the first time, a formulation of its own purpose. (Rorty, 1989, p. 12–13, emphasis added)

Here Rorty notes that even the great poets are *typically unable* to make clear their aim until they have achieved something. That is, in the process of making something new, the poets are not only unaware of what they will have produced in the end but also incapable of describing and explaining precisely what they are doing in the process of producing something that in retrospect will have been new. Painters do step back from their paintings, which enables them to see/find a posteriori what their preceding brush strokes have yielded (Marion, 1996). *Becoming aware* therefore has the character of (a) an event*-in-the-making, which is known as event only after the fact (Roth, 2013) and of (b) aspect dawning (Wittgenstein, 1997). At that point those who have become aware of something new (i.e., have learned it) describe what they have been doing using the new language and linguistic expressions and, thereby, producing an *a posteriori account*. A posteriori accounts do not have predictive qualities and, therefore, like Monday morning quarterbacking, have no *theoretical* value: they do not explain anything. The purpose of this study is to describe and (begin to) theorize precisely that movement from being unaware to being aware while the poets and learners do not yet know what they will have come to know when they are done. This movement I denote by the term *becoming aware*. Becoming aware inherently is a process of learning, because afterwards we are aware of something that we had known (been aware of) before. Becoming aware therefore is a quintessential learning process that we need to know about because it involves parts that currently dominant epistemologies do not or cannot explain.

Review of Studies on Aspect Dawning

The *dawning of an aspect* refers to the arriving of a new thing in conscious awareness—which is not and *cannot* be the result of an interpretation (Wittgenstein, 1997). A clear example in the literature on learning events in the sciences (i.e., “discoveries”) exists in the account of how the DNA structure came to be *found*. J.D. Watson had created cardboard shapes of the four chemical bases that he and his collaborators knew were present in the DNA molecule they studied and for which they wanted to find the structure. He describes what happened that morning:

[I] began shifting the bases in and out of various other pairing possibilities. Suddenly I became aware that an adenine-thymine pair held together by two hydrogen bonds was identical in shape to a guanine-cytosine pair held together by at least two hydrogen bonds. All the hydrogen bonds seemed to form naturally; no fudging was required to make the two types of base pairs identical in shape. (Watson, 1996, p. 207)

In this account, Watson describes shifting the different shapes in and out of various configurations. He had to do so because he did not know what he would ultimately know: two pairs, with members placed in particular ways, were identical in shape. This knowing is not only of the perceptual kind but also one of conceptual nature. Moreover, not knowing what the DNA molecule and its rungs will be looking like once “discovered,” like he could not have a plan to intentionally look for it. Quite accurately, he therefore describes that he was *becoming aware* that the adenine-thymine and guanine-cytosine pairs were identical. This awareness was both of perceptual and conceptual nature. For him to become aware, there had to be something that he could become aware of: the configuration of the two pairs. These pairs *preceded* his awareness. Watson did not direct his awareness but rather, the identity of the shapes of the two pairs *offered itself to him* rather than him looking for it. It was when he saw the configuration that he knew it was what he was looking for. Prior to that he did not know and, therefore, could not intentionally construct the shapes.

Watson writes that he *suddenly* became aware—he had an epiphany. That is, he was describing an instance of insight, when something unknown up to a point came *in sight*. He uses the adverb “suddenly,” which has the sense of “all at once” and “without preparation or warning.” Such a framing, however, obliterates part of the description, which also notes the *coming* of awareness and the *becoming* aware. There is a happening at work, a movement, at the end of which we are consciously aware (Depraz, Varela, & Vermersch, 2001). Watson does not write that he *constructed* awareness. As Rorty above points out, he *could not* construct it because he was becoming aware of the equally shaped pairs almost despite himself *following* his moving about of the shapes. Because we cannot construct awareness—we would have to be aware of our future awareness to do so—this study therefore contributes to evolving a post-constructivist account of learning.

We do not have to seek resource in the discovery accounts of famous scientists—though there are recommendations on cultural-historical grounds to take the toughest and extreme cases for studying psychological phenomena (Vygotskij, 2005). Instead, if we pay close attention then we can find evidence of the coming of awareness in the everyday classroom. Thus, for example, I had studied a group of tenth-grade students in a course on static electricity (Roth, 2006). In one of the two groups recorded, the students had great pains to consistently reproduce an effect that the teacher had demonstrated. The teacher had rubbed some material, including an overhead transparency, and then held to it a little glow lamp (Figure 1). It lit up, which the teacher suggested was due to the static electricity. After having conducted 116 tests, following another series of inconsistent results, Birgit, one of the four students in the group stared at the glow lamp and then said something like, “Oh, it is broken. It cannot work!” It is at that time that she had *become aware* of the fact that there were two electrodes, which Birgit (incorrectly) described as a broken lamp. Because she did not know that a glow lamp has two electrodes rather than one continuous wire like a classical light bulb, she could not intentionally look for it. There was then a movement from not being aware to being aware; and this part of the learning event—after all, she did come to know something that she did not know

before—requires a new, post-constructivist form of description. Moreover, the movement itself requires an appropriate theory that is consistent with the eventness of the event (Roth, 2013).

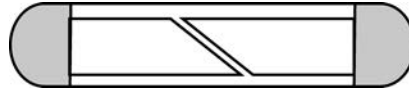


Figure 1. After 116 tests using the glow lamp, Birgit becomes aware of the gap between the electrodes. Three lessons later she becomes aware that one has to hold the glow lamp at the metal ends to make it work.

In another example, I had videotaped a group of second-grade students who were given the task to build the model of a mystery object hidden in a shoebox and which they could only touch but not see. (A detailed account of the classroom episode can be found in Roth, 2014.) One of the students, Melissa, had reached into the shoebox a total of seven times, each time emerging only to insist that the object was best described by the cubical model that she has built (Figure 2a). She not only insisted on the fact that the mystery object is a cube but she explained how she had determined it: by turning the object and holding her thumb and index fingers in a caliper configuration, which allowed her to measure the different faces and determine that “they all have the same size.” Her two peers insisted that the mystery object had a different shape. When the teacher insisted on coming to an end, another student described and demonstrated how Melissa could turn and test the mystery object with one hand (in the shoebox) and do the same with the other hand using a comparison object. The video shows Melissa apparently exploring with the right hand, while turning and touching her peer’s model with the left hand. Then, all of a sudden, her facial expression changes, exhibiting astonishment; she puckers her lips, then picks up her clay model and shapes it into a rectangular prism (Figure 2b). Now, after eight explorations of the mystery object for a total of 3:10 minutes, it had given itself as a cube. It was during the eighth exploration that a new form was revealing itself to her hand. Here, too, the underlying happening is one of becoming aware: the mystery object was taking the shape of a rectangular prism although it had felt like a cube during, and as a consequence of, the seven preceding explorations.



Figure 2. a. Melissa, after having explored with her hands the mystery object, has shaped plasticine into a cube. b. Eight trials later and after following a comparative procedure shown to her by a peer, Melissa exhibits surprise and then shapes the plasticine into a rectangular prism.

Several studies pertaining to physicists invited as experts in reading graphs from first-year university biology courses shows that researchers must not presuppose the givenness of what is on the page. Thus, one physicist, when stymied, was told by the research assistant that she had to look at the value of the curves but she answered, “I can’t help but see slopes.” It is not that she *interprets* slopes: she *cannot help* but *see* slopes. Mathematically, instead of seeing the values of birthrates as a function of population size, $b(N)$, she saw the slope as a function of N , that is, $\frac{d}{dN}b(N)$. In another study I conducted, what was to be seen as a graphical sign for a biological phenomenon (interaction of nutrients) arose in and from the verbal exchanges of two physicists who experienced the *dawning of an aspect*. Finally, *what* there was to be seen in two representations in an experimental biology laboratory—an image of the microscopic slide contents and a graph—was not given but emerged in the course of the verbal exchanges over and about the two; and the pattern in which the generated data related emerged as a form of a sudden gestalt switch within the research team. Without a thing, without an aspect, there was nothing to be interpreted; the latter process could start only when a new (perceptual or conceptual) aspect had dawned. Describing the movement from absence of a sign to the presence of a *new* and unknown sign is precisely the object of this study.

Becoming Aware: An Empirical Investigation

It has been noted quite some time ago that consciousness [*Bewußtsein*] is conscious Being [*bewußtes Sein*] (Marx/Engels, 1958). That is, Being does not have to be consciously aware of structure in practical activity and, on evolutionary grounds, is not inherently so.¹ The issue is pertinent to learning. Thus, even though

¹ For example, in experiences of flow or meditation, practitioners are not conscious of Being, do not make present or make present again, re-present.

children come to speak a language in grammatically correct ways, they are said to know grammar only when they are aware of the different parts of speech (subject, verb, object, etc.). Speaking is a mode of Being (Heidegger, 1977), but awareness of the parts of speech can come only when children already know to speak correctly. Like the poets referred to above, children can describe what they are doing with the words of their language when they already have learned this language. In this section, I provide an empirical case example of the movement from being unaware to being aware (of something): becoming aware.

Methodological Background

In this study, I draw on a form of studying phenomena of consciousness from a rigorous first-person perspective intended to provide descriptions that allow others to reproduce the targeted form of experience (Depraz et al., 2001). The method had originally been described and developed under the name of *phenomenology* by the mathematician-turned-philosopher E. Husserl (1976) at the beginning of the previous century. More recently, the experimental approach to phenomenology has been further developed as a method to generate data for the purpose of correlating phenomena of consciousness with neuroscientific studies (Varela, 1996). That is, this “hard-line” approach to phenomenology has little to do with the woe-me approach that one often finds in the literature using the same name, and it has nothing to do with the subjectivist approach termed *introspection*. Instead, it is an approach where the rigorous analysis of experience is brought together with third-person descriptions so that the two perspectives can be brought into alignment and be studied scientifically. This has led to medical studies that have allowed treating epilepsy in non-medical ways because the patients could identify features of their experience typical for the onset of a seizure, which could then be averted by non-chemical means (Petitmengin, Baulac, & Navarro, 2006). It also has found use in disciplines that are concerned with a more extensive set of tools for cognitive science (e.g., Schmicking & Gallagher, 2011).

A Case Study of Becoming Aware

Every single example of the phenomenon (becoming aware) sketched in this article would lend itself to deep analysis to show invariant features. However, none of the related studies produced sufficient data and sufficiently thick descriptions suitable to accomplish my purpose.² Thus, the particular event analyzed and described here is part of a growing database in which I document—in the form of descriptive notes, analyses, photographs, and other inscriptions—learning experiences, especially learning experiences of types that are not generally described in the learning sciences literature. For many years I have kept entries in my lab (research) notebook on particular learning experiences (a) in which I had suddenly realized something, i.e., had a “sudden” insight or (b) when I tried remembering something but could not precisely because I did not know the thing to be remembered. The following is but one of the many instances I have recorded,

² Such data may be acquired by means of the first-person method employed here, or by means of the second-person method that Petitmengin (2006) describes.

some of the very same nature under similar circumstances. Although *insight* frequently goes with perception, becoming aware pertains especially to conceptual issues.

On July 23, 2013, I have gone on a bicycle ride around the peninsula on which I live riding northwards along the highway (Figure 3a) when I am *becoming aware* of my lips forming the word “temple” just as I have been passing something that I now remember as a green “sign.” Like a word that is still ringing in our ears just after and although it has gone, I am aware of having articulated a word just after having completed it. A fleeting thought concerns the question whether an arrow (\leftarrow) has actually been there as well, but I am already past and cannot not verify its presence. I am now becoming aware simultaneously of having formed the words “Indian temple” and have come to grasp it *as* “Indian temple.” However, just before that realization and *while* articulating “Indian temple” I have not been aware of it—until the ending “-ple” has been coming off my lips. At that instant, too, there is a fleeting image of greenness in my retention that I am associating *after the fact* with the ground on which the “Indian temple” has appeared. Having passed the sign, I can no longer verify it. At that time I am *beginning* to realize: (a) I have not known of the existence of a sign pointing to an Indian temple; (b) I have not known that close to where I live—an area predominantly populated by white working and middle class (94%) and aboriginal populations—there is an Indian temple; and (c) I begin pondering where the temple might be because I have never seen it and whether it might be something like a meeting hall rather than a building that stands out.³



Figure 3. View of the highway during a bicycle trip while approaching an intersection. a. Farther away. b. About 100 m closer. (© Wolff-Michael Roth, used with permission)

³ On the same day, I recorded becoming aware of something brown, which when I was already past it will have been a dog. On another day, along the same route, I have precisely the same experience with another road sign that I have never seen before in the 16 years of passing there.

Analysis of the Case

From this case, we may learn five important lessons. First, we note that at least when we know and are aware of the road panel (“Indian temple”), it is quite prominent—at least when we are close up (Figure 3b). Despite this prominence, and despite having bicycled past this place for years, I have been becoming aware only on that particular day. Although we tend not to pay attention to such phenomena as part of our everyday lives—these experiences do not come to stand out in our awareness as interesting phenomena at all—these are actually quite common. During the same summer, several other roadside signs have revealed themselves to my awareness along this familiar trip during the same summer. I have described having become aware of prominent features such as a church or a pair of giant silos in other places (Roth, 2006). Both looking and the thing *precede* the awareness. Now that I know of the roadside panel, I can easily attend to its future appearance on the next bicycle trip I take on this highway and I can talk about it and my initial experience in its respect. That is, once I have become of the phenomenon I can make it present again (represent it), anticipate it, and construct other things with it. But until the instance when becoming aware begins, and right to the presence of awareness, to construction is not an appropriate verb.

Second, we note that there are temporal delays during the movement of becoming aware. The awareness of something green and the awareness of having formed with my mouth and lips what will have been the words “Indian temple” were after-effects. That greenness initially was only indeterminate in my experience in the same way as (a) a word is indeterminate when it only makes its way up to the tip of the tongue without actually emerging from our mouths or (b) we almost come to visualize something without quite arriving there (called *presque vue* in psychology). There was something like an indeterminate greenness inscribed with white that started the movement of becoming aware without that I could know that such a movement was in the course. It is only with hindsight that I will have been able to say that “something drew my attention.” In fact, this expression shows that in our experience it is something else that is acting (active tense of “drew), and, being subject to this action, my attention is drawn (passive tense). But in the final stages of becoming aware, the preceding indeterminateness still was resonating, a sense of an emerging greenness, the sense of having moved the lips prior to comprehending what was happening as my reading of a text. By the time I grasp the *What* (object) there has been, a sign that points to an Indian temple, I have already passed it. The awareness of green was associated with something still resonating in *retention*, that is, after it already has gone from the retina. At best, there is a dim sensation that remains, not the awareness of some/thing or the awareness of a green color. Similarly, awareness of the *What* of the speaking has followed the actual articulation. (Most people reading with their mouths forming the words are unaware of doing so.) More importantly, the comprehension of “Indian temple” occurred even later than the awareness of the text. This relation between forming a word and comprehending it became evident to me three weeks earlier, when I had become aware of just having passed a road-side sign: my becoming aware was correlated with the verbalizations /'ask ju:/ (“ask you”), /a 'skju/ (“a skew”), and /ə'skju:/ (“askew”). It was then that I suddenly become aware having passed a

realtor sign carrying the name “Paul Askew,” whereupon I was becoming aware of the thought that the person might have been teased or ridiculed. In none of these processes does something like *construction* occur—reception, being subject to something other than ourselves, are much better to describe what we actually experience rather than what some theory dictates us to believe.

Third, once I have become aware of the “Indian temple” inscribed in white on green ground, once it has become present in/to my consciousness, I am enabled to make it *present* again (*re-*), that I can represent it. That is, whereas the same road-side sign likely had been on my retina before, I could not make it present again as the object of my intentional activity. *Being aware* (consciousness) is associated with the faculty of making some presence present again. But, as the empirical data show, there is a delay between presence and awareness of presence, the latter always only following the former. Philosophers make this difference thematic in the distinction of Being [*Sein*] and beings [*Seiendes*] (Heidegger, 1977), the latter including the things (signs, words) that allow the former to be made present again, to be represented, and therefore to be present in conscious awareness.

Fourth, *becoming aware* is a movement in the course of which awareness becomes what it is: awareness of something. But the awareness of something as something is only the endpoint of the movement; it is only its result. The movement is so fast that under normal circumstances we are not aware of it. We therefore tend to call it *insight*, something is coming in sight. Precisely because agency is shifted here, the verb to construct is inappropriate. Having become aware of *becoming aware* especially during bicycle trips, my hypothesis is that in this particular kind of experience attentional processes are slowed down to the point that they may become objects to be studied systematically. Thoughts come to me during bicycle training when and while I am not at all seeking to think about research. This, too, is a common aspect of innovation and a topic of study by neuroscientists, psychologists, and phenomenological philosophers alike (e.g., Depraz et al., 2001). What I am interested here in describing is the *coming* of a thought, the *becoming aware* of an idea. We could construct this thought only if we already knew it in advance, and, therefore, could represent it. But thoughts are the result of dialogical processes (Vygotskij, 2005) and, therefore are unpredictable as the outcomes of all dialogical processes (Bakhtin, 1929/1994).

The fifth important issue for theorizing learning pertains to the mode of *becoming aware*. Because I neither knew nor was aware of the road sign, or knew that there was a temple, I could not construct it. Moreover, I could not even consciously start off becoming aware, because the movement arrives at an object—I become aware of *some/thing*—and this object inherently is available only after the epiphanic experience. Instead, I *find* myself comprehending after the fact rather than having intentionally produced comprehension. I could not make the sign the intent of learning precisely because I did not know (of) it. Instead, becoming aware generally and becoming aware of *becoming aware* is associated with a particular (*passive*) sensitivity, (*willing*) *receptivity*, and attention (Depraz et al., 2001).

Discussion

Mastery consists, precisely, in ultimately letting the unseen surge into the visible by surprise, unpredictably. (Marion, 1996, p. 60)

In this study, I direct attention to a phenomenon that under normal everyday condition tends to be so fast that we do not heed it, fail to notice it, and, therefore, that we are not becoming aware of it: the movement from unawareness to awareness, from not-knowing to knowing. The phenomenon is not just one of the perceptual kind; in fact, it is conceptual through and through, because in everyday life we do perfectly fine perceptually without conceptual awareness (e.g., we are unaware of our surroundings while walking through a city and talking to a friend or colleague). That is, although it may appear on quick reading that this paper is about perception, it is, on a deep level, concerned with awareness and therefore cognition.

In the classical (constructivist) approach, we learn by interpreting the world. This presupposes the existence of whatever is interpreted. The present study shows that the classical (constructivist) presupposition is unfounded. In this study, as in the third person study of students reported above, there is no evidence of something being in consciousness that the learner interprets. Instead, it is only at the end of the movement from unawareness to being aware that something—a new object, a new sign, or a new idea—comes to stand out. Thus, a distinction is to be made between a continuous seeing (understanding) of some aspect and the dawning (becoming conscious) of an aspect that had not existed before (Wittgenstein, 1997). In this study, I describe the movement denoted by *becoming aware*, that is, how we are becoming aware of something before it can become the object of our conscious and deliberate (constructive) activity. It is not that we see and understand something *as* something, that is, that we *interpret* as something, but rather we are confronted with the (perceptual, conceptual) thing that appears in our consciousness: we are patients rather than agents of this process. Even if we are asked to have to look differently at a situation, we sometimes cannot help but continue seeing it in the way we have done up to now—which is the case because we do not understand a thing according to an interpretation: “Seeing as . . .’ is not part of perception” (Wittgenstein, 1997, p. 197), but is through and through conceptual. In a strong sense, therefore, we are confronted with what *is given to our perception and understanding simultaneously*. This therefore explains empirical findings from a study of learning from demonstrations in physics.

In an Australian physics classroom, I conducted a controlled study students were asked to predict, observe, and explain a demonstration. The results show that some students saw motion where others did not with the students from each group subsequently providing explanations *why* they should or should not have seen motion. How is it possible that we see one or another, mutually exclusive phenomenon? There are many phenomena in the psychology of perception with which many readers will be familiar, including the dual images of (a) a vase / two faces, (b) an old / young woman (Gregory, 1996), (c) a duck/rabbit (Wittgenstein, 1997), (d) the double Maltese cross, or (e) the double (Necker) cube (Roth, 2012). Such instances tend to be taken as the result of constructions, where a person is said to interpret some material substrate in one or another way. But saying that people

construct what they see is not at all what happens. Something gives itself to seeing as and understanding. This was quite apparent in the studies of graphing reviewed above. Similar phenomena are reported when students look at graphs and are said to iconically confuse them with other images (e.g., maxima and minima of a sine curve and the turns of a race track). The way in which we come to see and understand, or rather, in which we are becoming aware, does not tend to be studied at all; and yet, when we do study it, it turns out to be not well described by means of the constructivist metaphor.

Readers are familiar with the phenomena at issue here, though precisely when *becoming aware* has not arrived at its conclusion: the tip-of-the-tongue, *presque vu*, and I-forgot-what-I-wanted-to-say phenomena. In the tip-of-the-tongue phenomenon, something we are trying to remember or say has not quite made it to our awareness. This would also be the case if I had not quite come to grasp that there had been something green, or if the “Indian temple” had not quite made it into my awareness. We are aware that something was in the process of becoming aware, sufficiently into awareness to the point that we have experienced the early stages without actually becoming aware of the thing as such. In the I-forgot-what-I-wanted-to-say phenomenon, something that we were apparently aware of has disappeared from awareness and we can no longer say what we wanted to communicate. But the disappearance is not complete, for there is a trace that allows us to be aware that something had been in awareness without there being a sufficient trace to know *what* it actually was. When we say that something “was dawning on me,” we actually refer to a temporal nature of an appearance that was known as something only after it had fully appeared in light.

The empirical evidence points to the fact that initially there is nothing in perceptual experience that could be interpreted: in the way Birgit was unaware of the gap in the electrodes, I was unaware of the roadside sign. The upshot of this investigation is that I cannot construct something as something if there is no *thing* to begin with. If construction were to be an appropriate description (metaphor), then I would have to presuppose the (material) presence of the thing (e.g., the written “Indian temple”). As this study shows, the written is not present in/to consciousness. There is a movement by means of which we are becoming aware. After having become aware I can then begin to ponder where there might be an Indian temple, as suggested by the roadside sign. That is, whereas construction might be the appropriate metaphor for describing/theorizing what happened after I had become aware, and in the context of what I already knew (had been aware) concerning the geography of my municipality, that which is consistent with our understanding of learning, the arrival of something we had not known before, is precisely what escapes such a description. Therefore, *construction* most likely is not the appropriate metaphor for describing and theorizing learning. Passive receptivity as condition and *becoming aware*—a unit including unawareness and awareness as two of its manifestations—constitutes a more accurate way of describing the arrival of the new, and, therefore, of learning. Mastery in learning, whether we consider a school student or a researcher, exists, as the quotation opening this section suggests in the case of the painter, in *letting* the unseen surge into the visible *by surprise*.

Because this occurs unpredictably, learners need to learn how to attend to these otherwise fleeting aspects of human experience.

Implications

Epistemological Implications

In this study I provide a description and analysis of *becoming aware*. The movement includes being unaware, latent awareness, and full awareness. Each of these three dimensions is but part of the whole movement that cannot be further reduced. Because of this, *becoming aware* is an appropriate unit/category—in the sense of the unit [*edinica*] analysis that is to replace analysis by means of elements (Vygotskij, 2005)—of *learning* because it embodies change. Unawareness, latent awareness, and awareness are but manifestations of the whole unit. It is a true unit of learning because it is a (holistic) category [*kategorija*] of *change* (rather than the difference between two things). The phenomenon of *becoming aware* shows that there is more to learning than construction. There is an essentially passive dimension of learning that lies in the blind spot of constructivism with its exclusive focus on agency at the expense of passibility. Precisely because we are unaware of some thing that we will eventually be aware of, we cannot make it the object of our intention. Moreover, even if we know that there is something that wants to become aware, sufficiently so that we are aware of the process without knowing what it is that wants to become aware, then we cannot do much about it, especially we cannot construct the thing or awareness thereof. The first-person study provides us with a means to describe learning phenomena not accessible in other ways and, importantly, to draw conclusions with epistemological implications: the limits and limitations of a constructivist metaphor for learning. The upshot of the present study is that *becoming aware* is the quintessential learning phenomenon—we come to be aware and know something that we had not been aware of and known before. Because of its essentially passive dimension, this learning phenomenon is not and cannot be described by means of a constructivist metaphor. Elsewhere I describe experiments anyone can conduct to make the *same* observations that I describe here (e.g., Roth, 2012).

Methodological Implications

In this study, I use a first-person approach to the study of learning. Such an approach is still uncommon in the learning sciences, which are by and large limiting their methodological toolbox to third-person approaches—and they do so even though first-person approaches have gained currency in the cognitive sciences (e.g., Cohen & Dennett, 2011; Nir & Tononi, 2010). Becoming aware is one of those phenomena that we know to be occurring and have manifestations of. But these eschew in-depth study from a third-person perspective because awareness always is the awareness of someone and of something. However, “hard-line” phenomenological inquiry—a form of inquiry aimed at scientifically rigorous

description—produces data that can be correlated with third-person methods. For example, becoming aware and changes in awareness can be studied under controlled conditions and used conjointly with functional magnetic resonance imaging (fMRI) methods (e.g., Carhart-Harris et al., 2011; Overgaard, Gallagher, & Tamsøy, 2008; Petitmengin et al., 2006). There is no reason why the study of learning phenomena, as these are experienced from within, ought not be an integral part of the methodological toolbox of the learning sciences. Recent work suggests that such “hardcore” phenomenological approaches arrive no less at generalizations, and sometimes are more generalizable, than experimental and quantitative approaches (Ercikan & Roth, 2014). By means of first-person investigations, we can actually study what underlies the awareness of one or the other shape. The study is based on within-person variations quickly shifting from one to the other appearance, which allows us to recognize the conditions under which we are aware of one or the other shape. For example, when we attempt to hold both images simultaneously in the above-mentioned double images—by keeping the image on the same place on the retina either through training or by using a device psychologists invented—we come to note that the entire visual field turns into a homogeneous grey (Roth, 2012). We may turn such findings into instructions for others to experience the same phenomenon, for example, where and how to look to see one rather than another thing. Because of this, these phenomena no longer are to be considered merely subjective; their *instructability* makes them what cultural psychologists call “interobjective” (e.g., Sammut, Daanen, & Sartawi, 2010). The present study also suggests that we might have to find conditions that slow the phenomenon to the point that it becomes accessible; and training generally is required to ready the researcher for investigating such phenomena (see Depraz et al., 2001). During think-aloud protocol studies involving experts and students/novices, we often observe participants being silent, not articulating thinking, which researchers address by means of directions such as “say what you are thinking.” In fact, participants may not be “thinking” at all, not in the way we commonly understand this phenomenon: they may be in fact waiting for the arrival of a thought. The method used here would be a prime candidate for exploring this aspect of cognition and instruction.

Instructional Implications

If learning were a simple matter of construction, then how the way in which we perceive something could be changed once we are told that matters are different than how these initially appeared to be. However, as the detailed case study referred to above showed, even if told repeatedly by peers and teacher alike, Melissa continued to perceive a cube when tactually exploring the mystery object. In the way the physics professor referred to above “could not help but see slopes,” Melissa could not but feel a cube. In that instance, something occurred that we might take as a lesson in (natural) pedagogy: another girl (Jane) actually comes up with a form of instruction that allows Melissa to move through a process of becoming aware that the mystery object felt differently. Whereas Melissa during the first seven explorations first touches the mystery object and then molds the clay or shows with

the clay model why the mystery object is a cube, Jane demonstrates how the mystery object and its model can be felt simultaneously. When Melissa does the same using Jane's model, we observe her undergoing a movement of becoming aware, which, once awareness has arrived, manifests itself in her face as surprise. This is followed by a reshaping of her model. In this case, two processes occur simultaneously, an "unperceiving" of the mystery object as a cube and the simultaneous emergence of perceiving it as a rectangular prism. *Becoming aware* involves both processes. In Jane's instruction, we see what kind of pedagogies might work for teachers to assist their students more generally. For example, teachers might then think about strategies that might assist the physicist Anne to change from seeing slopes to seeing the values of the curves. Gestures may play an important role, both when teachers interpret those students produce (Alibali, Flevares & Goldin-Meadow, 1997) and those teachers produce as part of their instruction (Poizzer-Ardenghi & Roth, 2009). There is a wide open field of investigative possibilities concerning instruction that fosters *becoming aware*.

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