Self-knowledge from Resistance Training

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Abstract

The problem of self-knowledge has been thoroughly discussed in the context of traditional epistemology. In parallel to that traditional approach, Ecological-Enactive Cognition (EEC) has emerged in the last 30 years as a genuine contender in the cognitive sciences. According to EEC, the unity of analysis of cognitive processes is the dynamics between brain, body and environment. In this paper, I advance an EEC approach to self-knowledge, which immediately suggests that knowing oneself is a matter of knowing what one's body can do. I then turn to resistance training, particularly weightlifting, and argue that it offers a paradigmatic case of self-knowledge in EEC's terms. I contend that periodically reaching the point of mechanical failure provides an important insight into self-knowledge. Thus, resistance training allows the trainee to achieve knowledge of themselves in a fundamentally practical manner—and doing so is transformative of the kind of actions they are capable of.

Keywords: self-knowledge; embodiment; weightlifting; know-how; mechanical failure

Introduction

Much of the mainstream contemporary epistemological debate centers on the challenges of defining epistemic concepts, such as *knowledge*, *justification*, and *understanding*, as well as exploring the putative relations between those concepts and adjacent ones. Parallel to those debates, and mostly independently from them, Ecological-Enactive Cognition (EEC) has drawn attention to our embodied ways of cognizing (Chemero, 2013; Di Paolo et al., 2017; Gallagher, 2017; Hutto & Myin, 2013, 2017; Thompson, 2007; Varela et al., 2016). EEC is situated on the radicalized camp of the research program on embodied cognition.[1] Its defining claim is that cognition is a non-representational (hence, non-propositional) emergent feature of the dynamics between organism and environment. Cognition is then positively construed as the exercise of sensorimotor abilities in exploring environmental regularities that matter for the agent. Whereas other recent approaches also emphasize the role of the body, but retain an updated notion of representation that makes room for embodiment (e.g. Barsalou, 1999; Clark, 1997, 2015), what is radical about EEC is the claim that cognition is not fundamentally representational, for it involves a direct engagement between organism and environment.

Accordingly, EEC entered the epistemological debate through the ongoing discussion about the nature of *practical knowledge* or *know-how*. Proponents of EEC typically side with Ryle's (1949/2009) view on the independence of knowledge-how from knowledge-that (Carvalho, 2021; Myin & van den Herik, 2021; Rolla & Huffermann, 2022), setting themselves against the intellectualism put forth most influentially by Stanley and Williamson (2001, 2017).[2] Aside from that topical intervention in the epistemological debate, not much else has been done to approximate those traditions.[3] In this paper, I

[1] In recent years, many philosophers have explored a combination of Gibson's Ecological Psychology (J. J. Gibson, 2015) and Enactivism (Varela et al., 2016), for instance: Bruineberg et al., 2018; Carvalho & Rolla, 2020; Heras-Escribano, 2019a; Kiverstein & Rietveld, 2018; Rolla et al., 2022; Rolla & Novaes, 2022; Segundo-Ortin, 2020; van den Herik, 2018, 2020; Vasconcelos & Rolla, 2023. The success of this enterprise legitimizes the use of 'EEC' as a unified branch of the broader research program of embodied cognition.
[2] For an exception that rejects all talk of mediating knowledge in basic cognition, see Hutto (2005).
[3] When it comes to the issue of knowledge of other minds, Gallagher and collaborators (De Jaegher et al., 2010; Gallagher, 2001, 2008; Gallagher & Varga, 2014) have advanced the view that knowing someone else's mental states is achieved through interaction. This can be seen as another intervention (to use Gallagher's own phrase) of EEC into the traditional epistemological debate.

explore another classic epistemological problem that could benefit greatly from an embodied approach, namely, the issue of *self-knowledge*. Whereas traditional debates about *self-knowledge* discuss how and whether we can have privileged access to our own mental states (Bar-on, 2004; Gertler, 2010; Moran, 2001; Shoemaker, 1996), the turn to embodiment suggests something radically different: if the mind is embodied, knowing oneself is knowing one's own body. This resonates with the professed anti-dualism of EEC, which takes the dynamics between brain, body, and environment to constitute the unity of analysis for understanding cognitive processes, and the mind in general. I then advance an EEC-inspired view of self-knowledge by discussing another, perhaps more exotic subject: resistance training—particularly, weightlifting.[4] I aim to show that, under certain conditions, resistance training offers a paradigmatic example of radically embodied self-knowledge. More precisely, resistance training allows the trainee to achieve knowledge of themselves in a fundamentally practical manner—and doing so is transformative of the kind of actions they are capable of. Crucially, recurrently reaching mechanical failure (a technical term to be discussed in section 4) shows the transient limits of one's bodily capabilities. These limits are transient because training transforms those capabilities precisely through the systemic enaction of those limits.

For this, I begin by outlining some desiderata of any theory of self-knowledge. Next, I present EEC, emphasizing some of its commitments that might contribute to the discussion on self-knowledge. I then present some of the key concepts of resistance training and sports physiology, and I close by combining these discussions by showing how weightlifting produces self-knowledge in accordance with EEC.

2. General desiderata for a theory of self-knowledge

On a broad construal, knowing oneself means knowing one's motives for acting, desires, intentions, emotions, thoughts, and so on. Until very recently in analytic philosophy, the issue of knowing the content of our thoughts has received special attention over the other

[4] I am using 'weightlifting' as a general term for the activity of lifting weights, not to be confused with Olympic weightlifting, a sport that nowadays involves two specific exercises, namely, the snatch and the clean and jerk.

possible subjects of self-knowledge. This is due to the rise of semantic externalism in the 1970s, according to which the meaning of the concepts we use is fixed externally (Burge, 1979; Hurley, 2010; Kripke, 1980; Putnam, 1975; see also Rowlands et al., 2020). If meaning is fixed externally, then what we think about is not entirely discriminable from the first-person perspective, jeopardizing the possibility of privileged access to our thoughts. Externalism, therefore, challenges the intuitive idea that we have special access to our own thoughts in a discriminative way.

In an attempt to bar that conclusion, Tyler Burge (1988) famously argued that a basic form of self-knowledge could be secured by the self-ascription of occurrent thoughts of the form 'I think that *p*'. That kind of ascription is self-verifying despite the content of '*p*' being fixed externally. Whatever 'water' means in the community of speakers I am part of, when I say 'I think that a glass of water would quench my thirst', that second-order thought is forcefully true (provided I am being honest). Notably, the issue with Burge's strategy is that it makes self-knowledge *cheap* or *effortless*, unduly merged with the notion of self-consciousness. It is one thing to be *conscious* or *aware* that I'm thinking that *p*, whatever '*p*' turns out to mean—it is quite another to *know* what I am thinking about. Unlike self-consciousness or awareness of one's own thoughts, knowledge seemingly requires some kind of effort from the agent: knowing *what I am thinking of*—or having discriminative access to the content of my thoughts—is not the same as simply *being aware* of having a thought and reporting that awareness. The lesson here is that, regardless of how the issue of externalism and self-knowledge is settled, self-knowledge should not be effortless but always a matter of cognitive achievement (Lawlor, 2009). Although applied initially exclusively to thoughts, that constraint—the *cognitive achievement* clause—is the first desideratum for any view on self-knowledge, even those views that consider other aspects of our mental life, as we will see below.[5]

[5] An anonymous reviewer brought to my attention that a person can become really good at introspection and therefore, can easily come to know their own thoughts. Such a case is clearly plausible, and it seems to challenge the cognitive achievement clause. In response, it seems that the effort required for successful introspection is diluted throughout the person's history of trying to know themselves, their practice of introspection so to speak, which I think corroborates the cognitive achievement clause. I am thankful for the opportunity to clarify that point.

The second and third desiderata for self-knowledge theories are closely related and hold prima facie plausibility, regardless of whether the source of self-knowledge is akin to perceptual knowledge (Armstrong, 1968) or whether it takes a different form (Moran, 2001; Shoemaker, 1996). First, self-knowledge is authoritative: under normal circumstances, there should be some asymmetry between what one can know about oneself and what others can know about them, as well as what one can know about others. In other words, self-knowledge and knowledge of other minds differ in a substantial way—a way that is yet to be specified by the view we end up endorsing. This is what we may call the *asymmetry* clause. On the other hand, that difference should not entail an unsurmountable gap, otherwise knowledge of other minds might become impossible. More precisely, if we take self-knowledge as the paradigm of knowing minds in general and assume that a person can never achieve the same level of success in knowing other minds as they can know their own (i.e. if we endorse an excessive asymmetry), then we swiftly slide into solipsism. Accordingly, the third desideratum is to avoid that conclusion—the *anti-solipsism* clause—and self-knowledge models can meet it either by rejecting that knowing one's own mind is the paradigm of knowing minds in general (as a behaviorist might take it, at the risk of failing to meet the asymmetry clause) or by rejecting excessive asymmetry.

The three clauses specify the general constraints that any theory of self-knowledge should meet. Before attempting to meet those desiderata in EEC's terms, I return to a previous point: the focus within analytic tradition on thoughts over the other plausible candidates for self-knowledge. As mentioned, it seems uncontentious that we can know our desires, intentions, fears, and so on, and ignoring these mental states is to forgo an important part of our mental lives (Cassam, 2014). Cassam exemplifies that idea by listing cases of *substantial* self-knowledge that are radically different from knowing that you have this or that thought, but that should nevertheless be philosophically examined. I quote his list in its entirety:

- Knowing that you are generous (knowledge of one's character).
- Knowing that you are not a racist (knowledge of one's values).
- Knowing that you can speak Spanish (knowledge of one's abilities).

> • Knowing that you are a good administrator (knowledge of one's aptitudes).
> • Knowing why you believe a controlled demolition brought down the World Trade Center on 9/11 (knowledge of one's attitudes in the 'knowing why' rather than in the 'knowing what' sense).
> • Knowing that you are in love (knowledge of one's emotions).
> • Knowing that a change of career would make you happy (knowledge of what makes one happy). (Cassam, 2014, p. 29)

Cassam dedicates the rest of his book to explaining how each kind of substantial self-knowledge can be achieved. Unlike Cassam, I am not particularly interested in the possibility of self-knowledge for the cases he listed. What draws my attention is the examples he brings forth. Notice that knowledge of one's *character*, *values*, *attitudes,* and perhaps *emotions* more saliently refer to one's inner mental life—in the sense that they do not (at least not explicitly) reference our bodily morphology.[6] This, of course, should be challenged; after all, in some cases, we can only come to know our character and values after putting ourselves to the test and observing our reactions in unforeseen circumstances. If those cases depend on our *doing*, they depend on our embodiment—but this is glossed over. Abilities and aptitudes could, in principle, be associated with ways of acting—which, by the same token, necessarily refer to our embodiment as well—but the examples listed above (being able to speak Spanish and being a good administrator) might be taken to suggest otherwise. Although, of course, being able to speak any given language is linked to our bodily morphology, and perhaps even more tightly linked to our way of gesturing, and being a good administrator involves material engagement with tools and shared symbols (Malafouris, 2013), the examples used are kept on an abstract, seemingly disembodied level. I suspect there is a reason why Cassam does not mention, for instance, the self-knowledge of how much you can deadlift, or of your aptitudes for running long distances or for muscular hypertrophy. These abilities are not radically different from

[6] Notably, Colombetti (2014, 2017) argues that affective states are already present in the most basic form of intentionality, for even basic life forms perceive their environments as meaningful (resourceful, inviting, threatening, etc.) to them, which scales up to emotional states in more complex life forms. It follows that emotions are fundamentally embodied as well.

being able to speak Spanish—but the difference here is that the former are explicitly *embodied* ones. On the other hand, one could think (mistakenly, I believe) of language mastery and aptitudes in general from a disembodied standpoint. Much of the early analytic philosophy has done exactly that, thereby obfuscating the ultimately embodied nature of many, if not all, of our aptitudes and abilities.

The point of invoking Cassam's list is to highlight a suspicion that even the commendable strategy of broadening the scope of self-knowledge to encompass substantial cases remains implicitly committed to a mind-body division. That division is what EEC aims to reject.

3. Radically embodied know-how

As outlined in the introduction, what is radical about EEC is the explanation of cognitive processes without appealing to representational content. This is done in subtly different ways by the specific branches within the research program on embodied cognition. Traditional enactivists explain cognition from the bottom up through the enactment of recurrent structures of sensorimotor engagements (Di Paolo et al., 2017, 2018; Varela et al., 2016), which in turn obviates internal representations of the environment. Others, however, adopt an eliminativist stance: the radical enactivism of Hutto and Myin (2013) claims that representational content, in virtue of having accuracy conditions, cannot be naturalized because semantic information cannot be found in nature. Thus, mental representations are rendered useless because, to the best of our knowledge, they do not exist in nature. Representations are deemed mere constructs inherited from modern philosophy, preserved by old-school cognitivism without any real explanatory work being done (see also Ramsey, 2007). Ecological psychologists (Chemero, 2009; Heras-Escribano, 2019b; J. J. Gibson, 2015) typically endorse a position closer to traditional enactivism, aiming to explain perceptual states through the direct detection and exploration of affordances, i.e., possibilities for action that relate to an agent's bodily morphology, skills, and interests. If informationally rich environments afford exploration through action, they do not *need* to be enriched internally (contrary to the 'poverty of stimulus' assumption that feeds into cognitivism). Given the success of ecological

accounts in explaining particular cases of cognitive states, internal inferences and mental representations become otiose—but they might still be needed to explain the performance of *some* cognitive tasks that are yet out of bounds for the ecological approach. This, in other words, characterizes a methodological pluralism regarding the role of representations (Chemero, 2013).

Whatever the varieties of radical embodiment we deal with, their goal is the same: to explain cognition through the performance of embodied abilities. Moreover, as these performances unfold, the cognitive system undergoes structural changes that can be construed as the entrenchment of habits, i.e., 'self-sustaining precarious sensorimotor schemes' (Di Paolo et al., 2017, p. 144). Habits are selected by virtue of their success, predisposing the agent to systematically engage with their environment and transforming the organisms in ways that facilitate the re-enactment of specific actions under the appropriate circumstances. Di Paolo and colleagues (2017) acknowledge that habits are self-sustaining, which can "harden" them. Thus, the actions associated with a hardened habit may hinder the organism's cognitive success by potentially limiting its possibilities for action. But this is not to say that habits are devoid of plasticity or amount to mere reflexes—for the organism can enact a network of metastable habits that counters eventual breakdowns between exercising a habitual action and achieving its intended success. So, for instance, if I develop a wrist injury and cannot hold a certain weight with my hand supinated (a habitual action that was successful up until this point), changing the position of my hand from supination to pronation might allow me to hold that same weight. Doing so recurrently turns the newly developed wrist movements into a habit. Transitioning between those habits is a metastability that ensures success in their enactment. A radically embodied account of rationality might take this adaptative success, and not inner calculations, to be the distinctive feature of rational behavior (Petracca, 2021; Rolla, 2019).

At this juncture, if we are to explain the kind of *knowledge* produced by direct engagement between embodied individuals and their environments, the best candidate naturally is *practical knowledge* (Myin & van den Herik, 2021; Rolla & Huffermann, 2022). The other kind of knowledge that could in principle characterize our bodily

performances is *propositional knowledge*. But that would be a non-starter unless we are willing to say that much of our proficient engagements with dynamic environments (crossing a busy street, doing the dishes, playing with our pets, etc.) do not constitute knowledge. Propositional knowledge entails the mastery of a language, and its combinatory aspect exceeds the character usually attributed to representations. In contrast, proponents of EEC argue that most of our engagements with the environment are not guided by descriptions of it, and those that are linguistically articulated, in turn, are not the expression of a language of thought, but the outcome of enculturation (Hutto & Myin, 2017; Malafouris, 2013) or shared practices that give rise to an embodied language (Di Paolo et al., 2018). Accordingly, known propositions are the exception, not the rule, regarding how we interact with and explore our surroundings through action. Plausibly, the fact that propositional knowledge has been historically more salient than practical knowledge is related to the fact that philosophers actively try to detach themselves from their practical engagements in order to think reflectively about philosophical questions. Philosophical reflection *is meant* to break the flux of ordinary life, and this may lead to the illusion that our mental life is primarily linguistically articulated, descriptive of a world that is "out there". Given the foundational character of philosophy, it is reasonable to assume that this illusion has spread to other areas and has helped shape the scenario of early cognitive sciences. This would explain, for instance, Moravec's paradox, i.e., the fact that it is easier to train artificial intelligences to do what humans find difficult and substantially harder to train them to perform actions that we are able to do in a quite natural manner (Moravec, 1995; see also Brooks, 1991).

Regardless of whether EEC introduces a significant divide between the engagement with immediate environments (say, avoiding collision with a wall) and the engagement with cultural aspects of our surroundings (say, halting at a stop sign) or whether there is no substantiation in talking about "basic" and "higher" cognition, know-how has been taken to play a crucial role throughout cognitive processes (Myin & van den Herik, 2021). That being the case, it stands to reason that know-how, in EEC's terms, could be applied not only to our engagements with the environment but also *to ourselves*, as a form of practical self-knowledge.

In order to see that, we can begin by following Rolla & Huffermann (2022), who conceive know-how as the stable success obtained by exercising the agent's abilities. *Stability* (not to be confused with metastability of a network of habits) in this context means that the relation between the agent exercising a certain subset of their abilities and achieving success is not accidental or due to dumb luck, but regular or recurrent. *Abilities* can be understood as the individual's dispositions for acting, which might include (but are not restricted to) habits. EEC and other varieties of embodied cognition would be primarily interested in embodied abilities, such as the sensorimotor structures that constitute habits discussed above, but the present account generalizes to include every kind of ability ascribable to a person (from being able to jump to being able to speak Spanish). So, an agent knows how to do something if, by exercising their abilities, they achieve success– not only in a particular case but also in sufficiently similar circumstances.

However, that provisionary description of know-how is incomplete, given the transformative aspect of cognition for EEC, which is specifically clear in the case of habit entrenchment. Because EEC emphasizes the chronologically extended nature of cognitive performances (at the developmental and the phylogenetical levels), know-how must be *transformative*. Know-how is transformative because it enables the agent to act with a higher degree of stability than in its absence. The skillful individual's higher degree of recurrent success is explained through the structural changes in their body. The main idea is that the transformative character of know-how is fundamentally tied to practice: acquiring or enhancing a piece of practical knowledge transforms the agent, changing their ability to perform certain tasks—so that its practice becomes more fluid and cognitively less taxing. As toddlers learn to walk, for instance, they explore many possibilities of muscle activation necessary to generate force, but, with practice, they select those more efficient to promote bipedal locomotion (Chang et al., 2006). On a related note, due to indetermination from the lack of structural development, a novice confronts a broad set of actions that are, in principle and from their relatively unskillful point of view, equally tenable ways of achieving a certain goal. However, not all actions are equally efficient in practice, and some are highly inefficient vis-à-vis the relevant goal. Learning minimizes uncertainty by entrenching actions that exhibit a higher degree of correlation with the achievement of the relevant goal, eliminating less efficient ones from

the horizon of possible actions by the more experienced individual (Carvalho & Rolla, 2020).

To summarize, when it comes to applying EEC's notion of know-how to self-knowledge, we must conceive of know-how as non-propositional and non-representational, a stable success obtained by exercising the agent's abilities. Moreover, know-how is transformative, for it enhances the stability and fluidity of cognitive performances through structural changes in the individual. By turning to resistance training in the next section, I explore how weightlifting can produce self-knowledge in accordance with EEC's epistemological stance.

4. Resistance training and knowledge of our bodily limits

Resistance training is any exercise that requires moving (or attempting to move) against an opposing force (Fleck & Kraemer, 2014; Stone et al., 2007). Resistance can be provided by external means (barbells, dumbbells, kettlebells, cable machines, elastic bands) or by the practitioner's own body weight, as in the case of calisthenics and plyometrics. It is also possible to produce resistance by combining external forces and bodily weight, as in mountain climbing. Empirical research points to many health benefits of such training, such as: 'increased strength, increased fat-free mass, decreased body fat, and improved physical performance in either a sporting activity or daily life activities […], changes in resting blood pressure, blood lipid profile, and insulin sensitivity' (Fleck & Kraemer, 2014, p. 1). However, the more common goal of practitioners of resistance training, especially weightlifting, is muscular hypertrophy (for simplicity, from now on, I will use 'resistance training' as synonymous with 'weightlifting'). Unsurprisingly, much of the specialized literature about weightlifting is dedicated to optimizing hypertrophic processes (see Krzysztofik et al., 2019, for a systematic review).

Simply put, hypertrophy is muscle growth, which is generally positively correlated with strength and power. More specifically, hypertrophy is the increase of muscle cross-sectional area, which is a gradual and long-term adaptation of the musculoskeletal system after the recurrent practice of resistance training. The mechanical tension generated by

weightlifting increases the volume of individual muscle fibers, provided there is a positive balance between protein synthesis and the breakdown caused by the mechanical tension (Ponce-González & Casals, 2022). Muscle fibers are surrounded by satellite cells, which are 'normally quiescent but become active when a sufficient mechanical stimulus is imposed on skeletal muscle [...] Once aroused, satellite cells proliferate and ultimately fuse to existing cells or among themselves to create new myofibers, providing the precursors needed for repair and subsequent growth of new muscle tissue' (Schoenfeld, 2010, p. 2858).

To understand how resistance training aiming at muscular hypertrophy can generate practical knowledge of one's own bodily limits in accordance with EEC, a few more definitions must be in place:

- Resistance training exercises are generally composed of repetitions and sets. A repetition is one complete motion of the movement. Two or more repetitions make a set insofar as there is no substantial pause for rest between them. Rest is recommended between the sets, and its duration varies according to the intensity of the workout (Fleck & Kraemer, 2014).
- Throughout a repetition, the relevant muscles are shortened and lengthened in a controlled manner. The muscles' shortening is the movement's concentric phase, and its controlled lengthening constitutes the eccentric phase. Isometric muscle action happens when a weight is held stationary without movement of the joints (Fleck & Kraemer, 2014).
- Proper lifting technique (or form) involves the activation of the relevant muscles targeted by that exercise (its prime movers or agonists), paired with the activation of the synergists (auxiliary muscles that help to move the weight) and inhibition of the antagonist muscles (those that would move the weight in the opposite direction) (Sale, 1988). For instance, the *lat pulldown* is a back exercise that primarily targets the latissimus dorsi and the teres major (the agonists of that movement). Among the synergists, there are the posterior deltoid, the trapezius, the rhomboid, and several other back muscles, whereas the main antagonist is the anterior deltoid (Sutton, 2021).

- Technical failure, or improper form, happens when the wrong set of muscles is activated/inhibited to complete a repetition. For instance, activating the anterior deltoid during the concentric phase of a lat pulldown is a common mistake that leads to suboptimal mechanical tension in the target muscles.
- The repetition maximum (RM) is 'the maximal number of repetitions per set that can be performed in succession with proper lifting technique using a given resistance' (Fleck & Kraemer, 2014, p. 3).
- The intensity of the workout is usually measured by the percentage of 1RM. High-intensity workouts are >60% 1RM (Nóbrega & Libardi, 2016), and can also be indicated by a RM-range typically of 4 to 6 repetitions. A low-intensity workout involves lighter loads, usually under 40% 1RM, or a RM-range between 12 and 20 (or even more) repetitions.
- Training volume is defined by the number of repetitions and sets performed in a session. A higher volume usually implies a lower intensity and vice-versa.
- Mechanical failure, also called 'maximal voluntary muscle action' (Fleck & Kraemer, 2014, p. 4) is 'the point during a set when muscles can no longer produce necessary force to concentrically lift a given load.' (Schoenfeld, 2010, p. 2866). So, for instance, the same weight becomes harder to lift at every repetition, up until a point in which the motor units recruited cannot move it concentrically without technical failure. Rest is then needed to generate more power (in another set) so that the same weight can be moved again.

As said above, the specialized literature in sports sciences focuses on optimizing hypertrophic processes. With that in mind, some advocate for a "sets to failure" protocol, where every movement is repeated to mechanical failure (Jacobson, 1981) (henceforth, unless explicitly mentioned otherwise, 'failure' refers to mechanical failure). The rationale is that reaching the point of failure creates a higher level of mechanical stress on muscle fibers, thus enhancing the regenerative physiological responses. Although current research indicates that training to failure creates no more stimulus to muscle fibers than stopping a few repetitions short of failure, at least in high-intensity workouts (Lasevicius et al., 2022; Nóbrega & Libardi, 2016; Refalo et al., 2023), my main claim in this section

is that periodically reaching the point of failure provides an important insight into self-knowledge, even if it is not optimal hypertrophic-wise.

Crucially, when moving a certain weight, it becomes progressively harder to move, up until it is impossible to lift it with correct form and without rest. Whereas an individual with an intermediate (and upwards) level of practice can easily perceive the point of failure and, therefore, stop the movement to avoid injury and secure maximal gains, a beginner might compensate for the perceived increased difficulty by engaging other muscle groups, which characterizes technical failure. In terms of ecological psychology, the same weight afforded moving but only *up until a point*—and then that affordance momentarily ceases to exist, thereby triggering alternative responses (which are perceived differently depending on the trainee's know-how). Thus, reaching failure shows the transient limits of one's bodily capabilities. These limits are transient because training can transform one's bodily capabilities over time if one follows the recommendations for rest, recovery, hydration, and nutrition during the hours and days after each training session. This means that through the adaptations of the musculoskeletal system from repeated bouts of resistance training, a weight once perceived as unmovable (i.e., did not afford moving) becomes gradually more movable, which can be done either by increasing the RM range or switching to a heavier load. For instance, for an absolute beginner, doing 3 sets of 10 repetitions of biceps curls with 5kg dumbbells might be extremely taxing, but the increase in hypertrophy and strength following repeated training sessions usually allows the individual to increase the training volume (adding more sets or more repetitions) or increase the intensity of the workout (moving up to 6kg dumbbells, for instance) with the same volume as before. If the individual previously had a 10RM (that is, failure happens when the 10th repetition is completed) doing curls with a 5kg dumbbell in each hand, the higher level of strength achieved after a few sessions may increase their RM to 12 with the same weight, or allow them to move 6kg with a 10RM—for the relevant muscles have already adapted to the previous weight and volume (Jacobson, 1981).[7]

[7] The biceps curl is a monoarticular movement composed of a concentric phase of elbow flexion and an eccentric phase of elbow extension, which can be done at several different shoulder angles. From a biomechanical point of view, it is one of the simplest exercises there is, and the main muscles it activates (biceps brachii, brachialis, and brachioradialis, whose stimulation varies depending on palm position) are relatively isolated from other muscle groups. Other exercises, such as squatting, bench pressing, and

The main points here are, firstly, the subtly different ways that know-how permeates weightlifting. As Sale puts it when discussing electromyographic studies: 'the expression of voluntary strength may be likened to a *skilled act*, in which prime movers must be fully activated and synergists and antagonists appropriately activated' (1988, p. 135, my emphasis). This means that moving weights with appropriate form is far from trivial, and that practice allows the trainee to optimize the energy allocated by focusing on which muscles to activate/inhibit for a given exercise, which is a matter of know-how or skill. Relatedly, there is a differential response by individuals with higher levels of training when they approach the point of failure in a given exercise. Being sensitive to when a weight no longer affords moving is a matter of know-how. Alternatively, perceiving the imminence of failure during a set is something that an intermediate or a more experienced trainee can do without prejudice to the technique of their execution, whereas a beginner might struggle to reach that point whilst maintaining proper technique. There is, in fact, a good prima facie rationale for this: after all, weightlifting is putting one's body under mechanical stress in order to stress specific muscle fibers in a controlled manner, which then triggers the regenerative physiological responses that ensue hypertrophy and strength gains. Without proper training, it is instinctive to *evade* that uncomfortable and physically stressful situation. Learning how to lift weights, in turn, enables the trainee to endure that mechanical stress and optimize their energy expenditure to maximize the desired gains.

Moreover, there is no way for an untrained individual to know beforehand their point of failure for any given exercise. That is, *failure can only be discovered in practice*. Finding out one's own point of failure essentially requires a certain level of mechanical stress dealt to the muscles—which means it naturally happens at an embodied level. There seems to be nothing representational or propositional in the discovery of one's failure point, unless, of course, the person registers discursively their point of failure after the fact. But during the exercise, talk about propositions and representations is completely otiose from an

deadlifting are radically different because they are heavily composed; that is, their execution involves the coordination of many muscle groups simultaneously. As such, their proper execution (when good form is maintained) requires a higher level of know-how than isolated exercises such as the biceps curls.

explanatory point of view. In other words, the felt sense of one's own limitations need not be represented or articulated propositionally because, as it happens, the individual is in direct contact with the environmental constraints that inhibit their movements. That is, the trainee is in direct contact with the weights as these become increasingly more difficult to move—and, as muscle fibers are recruited and energy sources are depleted, affordances cease temporarily to exist. This direct relation, therefore, forgoes the need to ascribe representational states to explain the perception of one's limitations.

The second important thing I want to highlight is that resistance training brings individuals to their own physical limits. More specifically, it shows which weights afford moving and which do not. Crucially, recurrently reaching those limits transforms them because it expands the range of affordances available to a subject. This expansion is done autonomously, in the enactivist sense that it is the product of the organism's own doings and is not imposed externally. One can relate this to the entrenchment of new habits by structural changes in the organism, which, therefore, constitutes a gradual change in the possible dynamics between the organism and the environment. New affordances open up with practice, potentially modifying agent-environment interactions. To put it differently, the expansion of the range of affordances through resistance training is, *by force of identity*, the musculoskeletal adaptations undergone by the individual's own doings, and not something that happens over and above their physiological change.[8]

The latter point relates to the issue of know-how and propositional knowledge discussed previously. The overarching results of several training sessions (with proper rest, hydration, and nutrition) transform the individual and enable or enhance their action

[8] Notice that the changes in agent-environment relations are not exclusive to the gym environment but happen in any environment in which moving weights might be needed, such as picking up luggage, carrying an injured person, moving boxes of books, etc. As indicated above, new affordances open up once one becomes more accustomed to lifting weights, broadening the range of possible actions for an individual. So, although physical changes from resistance training are generally appraised by their aesthetical nature, they are not *merely* aesthetical. They are essentially functional—because they enable a broader range of actions—and they transfer to other environments, potentially modifying everyday activities.

possibilities, but this does not call for representational states or propositional knowledge. Even when trainees do sometimes think to themselves, "I know I should lift this way and not that way" (etc.), such pieces of propositional knowledge are merely incidental to the adaptive processes that happen on an embodied level. Similarly, verbal instructions ("do it like *this*, not like *that*") do help, but they are secondary and even disposable if we consider that discovering one's own bodily limits in resistance training is fundamentally a matter of embodied know-how indexed to the act of lifting that weight. The same thing goes for counting repetitions, keeping a log of one's training sessions, counting volume, calculating intensity, etc. These are all helpful activities to track progress, but they are not the progress itself. One's physical progress is fundamentally practical, reached specifically through the enaction of one's physical limits and the structural transformations that result from those recurrent actions. Likewise, training involves planning and oftentimes studying how an exercise should be done. Although this plausibly happens at a propositional level, to reiterate, it is not this propositional knowledge *per se* that causes musculoskeletal adaptations and the enhancement of one's embodied self-knowledge.

In a similar vein, the talk about "mind-muscle connection" has become widely popular among weightlifters. This is the claim that one can increase muscle activation by driving attention to it during an exercise. This sparked empirical research that corroborates the advantages of concentrating on the target muscle during the lift (Calatayud et al., 2016, 2017), but the dualist phrasing might be misleading. Schoenfeld and Contreras (2016), for instance, describe the so-called mind-muscle connection as the 'internally focused strategy [which] involves visualizing the target muscle and consciously directing neural drive to the muscle during exercise performance' (2016, p. 27). Framed like this, the phenomenon does not smuggle dualist assumptions.

At this juncture, it should be clear that what is special about resistance training when it comes to discovering and transforming one's own bodily limits is the notion of *mechanical failure* under controlled conditions, that is, conditions autonomously enacted by the trainees themselves. Because failure is enacted by the agent, it fundamentally differs from having an external impediment (such as an injury or any other form of limitation) that prevents proper movement and effective use of force. Moreover, although

it is possible that other physical activities, such as endurance training, have a similar epistemic profile, their physiological bases differ, which, in turn, plausibly requires a different analysis. More precisely, muscular hypertrophy is believed to be greater in type IIA and type IIB muscle fibers, which are fast-twitching fibers. Type IIB fibers, which have a greater cross-section area, are recruited under high-intensity workouts and transformed into type IIA fibers (Fry, 2004). Type I fibers—the ones at play in endurance training—on the other hand, are slow-twitching and are not usually linked to resistance training and its physiological adaptations (Ponce-González & Casals, 2022). Moreover, because of the characteristics of type II fibers in comparison to type I, the energy sources of the former are anaerobic (the phosphocreatine system and anaerobic glycolysis), whereas type I fibers are fed by oxidative phosphorylation (Fleck & Kraemer, 2014). I am not saying, therefore, that endurance training (for instance, running long distances) is not capable of bringing forth self-knowledge of one's own bodily limits, but it would do so in a different physiological manner than the one upon which I am basing my analysis here. "Running to failure" (whatever that might be) would hardly imply any endurance gains.

5. Meeting the desiderata for self-knowledge

Finally, I want to return to the desiderata for self-knowledge outlined in section 2. But for this, my argument depends on the assumption that we can unproblematically talk about a *self* within the EEC framework. One could, in principle, raise an issue here, given EEC's emphasis on agent-environment codetermination. This could seem to blur the boundaries of the self, thus challenging that crucial assumption. However, that is not such an acute problem for enactive views that borrow the original insights of autopoietic theory (Maturana & Varela, 1980), for individuals enact their own boundaries asymmetrically in environmental exchanges, which distinguishes them ontologically from their environment (see Di Paolo et al., 2017, chapter 5; see also Werner, 2020). EEC, in general, can rely on that ontological asymmetry. Therefore, the idea of a *self* (an embodied and enacted one) is acceptable for EEC, so we can advance the talk about *knowing oneself* within the EEC framework.

Having discussed how resistance training transforms and enhances the trainee's field of affordances, we can see how radically embodied self-knowledge acquired from that kind of practice meets all the desiderata for a sound theory of self-knowledge. First, knowing what weights one can (or cannot) move in good form is undoubtedly a matter of achievement—sometimes a very humbling one—and, as such, it is far from trivial. It requires recurrent training sessions, which in turn require dedication and the endurance of pain. Relatedly, it requires learning to discriminate the good pain of mechanical tension from the pain of articular injuries, as well as learning to perceive the healing processes after bouts of resistance training and letting the pain run its course before hitting the same muscle group again. These are bits of self-knowledge that one achieves through practice and practice only.

Secondly, self-knowledge from weightlifting is deeply authoritative, because it stems from one's own doings and, given that it is tied to one's bodily morphology, it cannot be fully accessed externally. People with different types of bodies may exhibit resistance or ease to certain exercises and exercise variations and, therefore, can develop specific ways of performing them. For instance, competitive powerlifters can perform two variations of deadlifting, a popular exercise in which the competitor must lift a barbell from the ground up to around their waist. Some prefer the conventional variation, where the competitor has a narrow stance with feet slightly turned outwards, holding the bar on the outer sides of their legs, whereas some prefer the so-called sumo variation. This variation requires a wider stance, feet turned outwards at a wider angle, and holding the bar on the inner sides of their legs. Although research does not indicate conclusively which variables dictate the preference for one variation over another, some research suggests that the conventional deadlift puts greater mechanical stress on the hip flexors and spinal erectors, whereas sumo puts greater mechanical stress on the knee extensors (Escamilla et al., 2000). This shows that to figure out which variation one feels better doing is something only the person can know about themselves.

Thirdly, even though self-knowledge from resistance training is authoritative, a trained eye is able to perceive in another practitioner if they exhibit proper form, if their range of motion is appropriate, if there is a risk of injury in the way they are moving the weights,

or if they are approaching their point of failure given a progressively slower tempo of the concentric phase for each repetition. Again, a *trained* individual can know whether another person is about to reach failure (for instance) because they developed the relevant know-how, but no one can tell what their point of failure is without practice. So, although there is an asymmetry in knowing about another person's bodily states, this asymmetry can be slightly blurred through practice and skill, but never completely surpassed.

To summarize, as the practitioner of resistance training systematically trains to failure, they discover and transform their bodily limits, thus achieving a piece of knowledge about themselves in a fundamentally practical and highly effortful way. This, I emphasize, happens under very specific conditions that are particular to resistance training. Two important things follow from this: firstly, weightlifting offers an interesting case study for an embodied approach to self-knowledge, as I have begun to develop here. Secondly, it is not obvious (at least without further consideration) that its characteristics transfer to other practices aimed at self-knowledge.

6. Conclusion

The preceding sections show how resistance training can be a source of radically embodied self-knowledge, in the sense that the practical knowledge of lifting weights (1) unveils one's own bodily limits, something that can only be achieved through practice, and (2) transforms the individual by ensuing musculoskeletal adaptations that broaden the space of affordances available to them, i.e., changes what they can effectively do. This can be done either by increasing the volume of their training (with constant intensity) or by increasing its intensity (with constant volume). This, I submit, is a fundamental kind of practical self-knowledge which is perfectly in tune with the embodied turn promoted by embodied cognition in general and EEC in particular. Importantly, paying attention to our self-knowledge at a fundamentally embodied and practical level does not preclude the acquisition of self-knowledge of other (higher) forms, such as knowing *that* one's own motives and beliefs are so-and-so. The latter remains an important part of our knowledge about ourselves, and here I remain neutral on whether it can be explained by tools other than those deployed by EEC in its explanation of embodied cognition. However, we must

bear in mind that a more thoroughly radically embodied approach to self-knowledge would explain how even our beliefs, motives (and so on) must fundamentally relate to our doings in the world. Although it is certainly possible to pursue such a comprehensive embodied explanation of knowing oneself, it is not the subject of this paper.

I want to discuss one final possible objection. One could say that this approach makes self-knowledge an empirical matter. One might claim that self-knowledge should be achievable a priori, obtained regardless of one's external conditions. I believe these questions are misleading because what is crucial about a theory of self-knowledge is that it meets the desiderata discussed in section two, regardless of whether it does so in empirical or aprioristic terms. Moreover, to the extent that EEC takes the dynamics between an embodied organism and its environment to be the unity of analysis of cognitive processes, a stark distinction between the internal and the external loses its prima facie plausibility. And because EEC is developed within a broader naturalistic framework, it naturally leads to a notion of self-knowledge (and knowledge more generally) that is, as a matter of principle, uncommitted to the a priori. If one has a problem with the proposal developed here under the correct assessment that it brings empirical matters into consideration of knowing oneself, the problem is not specific to this proposal but to the research program of embodied cognition more generally. And finally, because this paper is not intended as a defense of EEC, but as an application of its tenets in a hitherto underexplored territory, it should not be held accountable to a defense of the naturalistic framework in which EEC is developed.

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