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Choking RECtified: embodied expertise beyond Dreyfus

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Abstract On a Dreyfusian account performers choke when they reflect upon and interfere with established routines of purely embodied expertise. This basic explanation of choking remains popular even today and apparently enjoys empirical support. Its driving insight can be understood through the lens of diverse philosophical visions of the embodied basis of expertise. These range from accounts of embodied cognition that are ultra conservative with respect to representational theories of cognition to those that are more radically embodied. This paper provides an account of the acquisition of embodied expertise, and explanation of the choking effect, from the most radically enactive, embodied perspective, spelling out some of its practical implications and addressing some possible philosophical challenges. Specifically, we propose: (i) an explanation of how skills can be acquired on the basis of ecological dynamics; and (ii) a non-linear pedagogy that takes into account how contentful representations might scaffold skill acquisition from a radically enactive perspective.

Keywords Choking effect · Embodied expertise · Skill acquisition · Radically enactive/embodied · Cognitive science · Sports science · Sports psychology

In general, if you try to reflect on the source of the intelligibility of the situation, that is, if you try to think about why things are going so well rather than just letting yourself be

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drawn to respond directly to the solicitations lit up by the current situation – you will at best perform competently. At worst, you will lose your skill altogether.

– Dreyfus, The Mystery of the Background Qua Background, 2012, p. 2

1 Beyond the Dreyfusian model of expertise

When the pressure is on – when getting one's performance right matters most – there is always a risk of choking – of failing in the execution of familiar actions of the sort one has easily succeeded in performing countless times before. Counter-intuitively, the risk of choking is much greater for expert performers than for novices. Why this should be so has long occupied the attention and efforts of scientists of various sorts who seek to get to the bottom of this puzzling phenomenon.

The most popular philosophical model for understanding what happens when we choke is broadly Dreyfusian. For Dreyfus true expertise is a matter of making appropriate responses to the relevant contextual saliences – responses that are solicited at just the right times and to the right degree without the need for any explicit representation of the features in question or any detailed consciousness of the processes involved. Choking occurs when performers interfere with the execution of their performances when giving explicit, conscious attention to the aspects of those performances.

In broad outline this basic Dreyfusian explanation of choking – and its vision of the nature and acquisition of skilled expertise – is alive and well today.[1] Beilock (2011), for example, provides an up-to-date review of many converging lines of evidence that support the basic Dreyfusian idea from sports science, cognitive and developmental psychology, and neuroscience (see Cappuccio's introduction to this special issue for further details). Beilock's (2011) final take-home message, though importantly qualified, is decidedly Dreyfusian in spirit. By her lights, choking is indirectly brought on by worries – worries that provoke experts to stand back and explicitly examine their performances. It is such attempts at examination, as Dreyfus would have it, that lie at the root of choking: "too much time and concentration can be a bad thing because we are tempted to tinker with skills that are best run off without interruption" (Beilock 2011, p. 38). In short, "heightened attention to detail can actually mess you up" (ibid, p. 243).

Supplying a parade case of choking, Beilock (2011) writes:

> A basketball player who makes 85 % of his free throws in practice may miss the game-winning foul shot because, in an attempt to net the ball, he starts monitoring the angle of his wrist or the release point of the ball. After thousands of free throws these are not things that our basketball player would normally attend to

[1] Our primary aim in this paper is put some meat on the bones of a radically enactive, embodied account of the roots of expertise and how it is acquired. Although we begin by discussing Dreyfus-style accounts of choking we fully accept that more philosophical work is needed in order to clarify whether 'choking' picks out a well-defined phenomenon. We agree with other contributors to this special issue that the standard Dreyfusian formulation, for all its popularity, leaves the notion of choking under-conceptualised. More work is needed in order to assess claims about the empirical support that popular explanations associated the standard formulation are said to enjoy (see Christensen, Sutton and McIlwain (this volume), Papineau (this volume)).

> and in trying to bring parts of his movement that normally run outside working memory back into it he disrupts his performance (p. 245).

Her overall conclusion is that a, if not the, major reason why experts choke is that they "think too much about activities that are usually automatic" (Beilock 2011, p. 7). Talk of successful expert performances as being somehow thoughtless, unconscious or automatic pervades Beilock's (2011) account. She cites the fact that basketball aficionados' use of the accolade 'unconscious' "to describe a shooter who can't seem to miss" (p. 236). Relatedly, she quotes a range of sportspeople, trainers and coaches whose reflections on expert performance appear to support the Dreyfusian model. When things go smoothly they speak of 'keeping their minds blank' – advising that 'when you have to stop and think about things is when they go wrong'; 'Don't think, just do'; 'there is no time to think'; 'you let your body take over' (Beilock 2011, pp. 76).

Beilock (2011) locates the ultimate source of choking, as does Dreyfus, in the bad consequences of giving explicit attention to one's performances rather than allowing one's expert skills to be run off automatically in a mindless way. In this respect Beilock (2011) can be thought of as endorsing the basic Dreyfusian explanation of choking.

In another respect, Beliock's detailed account of what lies at the basis of such expertise is decidedly un-Dreyfusian in that she is wedded to a brainbound representationalist understanding of the roots of expertise. This commitment is evident, for example, in her favoured explanation of the way in which experts in a given domain often struggle to understand and predict the basic procedural steps or 'how-tos' that novices must employ when dealing with that domain – steps or procedures with which the now-experts were allegedly once familiar. As this inability has serious negative practical implications – especially for managers or coaches – its sufferers are deemed to be afflicted by the 'curse of expertise'.

On the surface level Beilock's account of what lies behind this 'curse' agrees with the standard, off-the-shelf, Dreyfusian explanation of the basis of this kind of systematic failure: experts have long ago forgotten the instructional steps that they once explicitly relied on – those they once held in mind – when first mastering the relevant skills. Beilock's hypothesized explanation for this forgetting goes as follows: as experts become more practiced in their skills the information that guided them and originally assisted them in learning those skills is transferred from explicit working memory to procedural memory. Once lodged in procedural memory the details become hard to access or recover. In this sense procedural memory is taken to be "implicit or unconscious" (Beilock 2011, p. 19).

Beilock (2011) expands on the differences between working and procedural memory in the following rough-and-ready way:

> our memory (and the tasks we engage in) can roughly be divided into explicit and procedural forms. In the former case you have activities such as adding numbers in your head, reasoning through a difficult issue with your client, or recalling what was said in a heated argument you had last week with a coworker. In the latter case, it's taking a golf swing, landing a double axle on skates, or operating a mobile phone … different skills rely on different types of memory (p. 26)

Beilock takes it to be scientifically well established that our explicit, working memory and procedural memories are located in different brain regions (the former

mainly occupying the pre-frontal cortex and the latter occupying sensorimotor regions, such as the motor cortex, basal ganglia and the parietal lobe). The relative location of stored memories figures in her explanation of why procedural memories cannot be readily accessed. Apparently one reason why the relevant information is hard to retrieve is that it is 'housed in' or 'resides in' or 'stored in' different parts of the brain (Beilock 2011, p. 20. See also pp. 50–56). Taking Beilock at her word, it appears that the transfer of information from one memory storehouse to another (hence the forgetting) is at least partly responsible for experts' inability to occupy the perspectives of novices (Beilock 2011, pp. 14–21).

Moreover, in elaborating her understanding of 'what' is contained in procedural memory – and hence what grounds expertise – Beilock (2011) further reveals a commitment to the idea that we first master skills by internalizing a certain set of rules. She tells us that:

> You can think of procedural memory as your cognitive toolbox that contains a recipe that, if followed, will produce a successful bike ride, golf putt, baseball swing, or fully operating mobile phone. Interestingly, these recipes are largely outside of your conscious awareness (Beilock 2011, p. 19, emphasis added).

By these lights, what really matters to the execution of expert performance is which brain-based memory store – long term or working memory – is actively grounding and guiding skillful activity. Consequently, Beilock tells us, "how exactly pressure causes a performance to hiccup depends on what we are doing and the type of memory that is driving how we execute that particular skill" (Beilock 2011, p. 26, first emphasis original). In line with this idea, her 2011 book is filled with the following sort of remarks about the cerebral locales of the true basis of our skills: "added control can backfire, disrupting well-learned sports and even musical performances that operate outside of the prefrontal cortex" (p. 241). Thus, choking occurs when we call on the 'cognitive horsepower' of the pre-frontal cortex in ways that interfere with the exercise of sensori-motor expertise. The execution of smooth performance requires letting "other brain areas such as the sensory and motor cortex take over" (Beilock 2011, p. 77).

In framing her account of expertise in such brain-based, representational terms it may seem that Beilock's (2011) account of expertise and explanation of choking is, on the face of it, in direct tension with the emphasis she elsewhere lays on the need for our best theories of skilled, expert performance to embrace the lessons of embodied cognition (see Beilock 2008). Yet this is not so. To see why it is important to remember that there are quite diverse ways of understanding the nature of embodied cognition. Advocates of so-called moderate – or more accurately, Ultra Conservative – accounts of Embodied Cognition (Ultra CEC for short) see no need to make any serious revisions to traditional cognitivist thinking about the basic nature of cognition. Ultra CEC accounts attempt to accommodate facts about the role of embodiment in cognition while continuing to conceive of cognition as wholly representational, entirely brainbound and, possibly, even modular. Nevertheless such approaches qualify as embodied accounts of cognition because they posit representations with (1) special bodily formats and (2) special contents representing features of the body, and they assume such representations play a quite central and fundamental in cognition – much more of a role than traditionally supposed (Gallese and Sinigaglia 2011; Alsmith and de

Vignemont 2012; Goldman 2012). Ultra CEC accounts qualify as embodied theories of cognition because they break faith with traditional thinking on this one issue – however theorists of this stripe continue to agree with classical cognitivists in thinking that the real work of cognition always boils down to manipulating representations in the brain.

Beilock appears to be committed to some version of Ultra CEC view. Even in her 2008 paper, in which she makes the case for acknowledging the importance of embodied approaches, she makes claims that reveal that she remains fundamentally wedded to many central elements of old school cognitivism. On the one hand, she holds that cognition is fundamentally dependent upon an individual's history of embodied interactions – or as she calls these, "previous action experiences" (Beilock 2008, p. 20). Yet, on the other hand, she also makes it clear that expertise – even when embodied – is really, at root, a matter of 'representing information'. She writes:

> to the extent that our knowledge is underlain by neural operations that embody previous actions and experiences, then those with extensive motor skill experience in a particular domain should represent information in that domain quite differently than those without such experiences (p. 20, emphasis added).

There are general reasons for scepticism about representational theories of mind and their ultimate explanatory payoff that ought to make us wonder how experiences grounding a person's actual embodied engagements boil down to gaining an "understanding of how individuals represent and comprehend information in their environment" (p. 20, emphasis added).[2] But, even if we put those worries aside, some unwelcome implications flow from Beilock's adherence to an Ultra CEC account of the basis of expertise – implications for her thinking about the situation of novices and how skills are best acquired.

For example, Beilock (2011) assumes that cognition is primarily a matter of holding 'pieces of information' in mind. Commitment to this idea drives her to conceptualize expertise, at least in some cases, as involving learning 'special' tricks – tricks designed to "circumvent normal memory limitations" (p. 73). In this regard she cites experiments by de Groot (1965) that reveal the critically important role of extensive practice in accounting for chess masters' "extraordinary memory for chess situations that they might see in an actual game" (p. 71). Unlike those new to the game, "the chess master was seeing individual chess pieces organized together in some meaningful way – for example, a certain attack sequence designed to capture an opponent's rook" (p. 73).

There is nothing to object to here. But, in line with her Ultra CEC thinking, Beilock (2011) adds an additional twist to this story – suggesting that what distinguishes the expert from the novice is that the former employs a 'special' trick of 'chunking' information so as to enable the expert to hold "fewer separate pieces of information … in memory" (p. 73). Accordingly, in coming to master their game, chess masters

[2] Although evidently wedded to representationalism in key respects, Beilock's account moves beyond the traditional classical cognitivist story. For example, she allows that the contents involved in such cognition need not take the form of amodal propositions. Distancing herself from classical cognitivism in this one respect, Beilock gestures to work by Barsalou (1999): she allows that the kind of representations of interest to understanding skilled expertise can be conceived of as "multimodal traces of neural activity that contain at least some of the affordances and motor information present during actual sensorimotor experience" (Beilock 2008, p. 20).

"turn many different pieces of information into one" (p. 74). Beilock goes on to recommend this chunking technique as one means of reducing the risk of choking since "bundling information can also be advantageous for performing under pressure … for keeping track of lots of different pieces of information" (p. 74).

Yet proposing a training regime based on learning such special memory tricks is bound to raise more questions than it answers: How is this many-to-one informational transformation achieved? How could someone be trained to do this? How and why are such memory tricks connected to extensive chess experience? The idea that experts need to master 'special' memory tricks, as opposed to merely developing skills through sustained practice involving ordinary acts of memory, is a questionable proposal that adds unnecessary theoretical steps into the story of the acquisition of expertise. More than this, it paints an odd picture of the predicament of the uninitiated.[3] An implication of Beilock's proposed account appears to be that the basic cognitive stance of novices – their normal state of mind – is one of confronting a vast array of meaningless items, items that are individually treated as many diverse 'pieces of information', so many, in fact, that they struggle to commit them all to memory.

Of course, this is not the only available explanation. A simpler, cleaner one is that lacking the relevant experience novices simply fail to see the same set of affordances as chess masters. This is not because they fail to see the arranged chess pieces in any meaningful way at all or because they have yet to master special memory tricks. Rather it is because, due to their inexperience, the chess pieces afford a quite different and more limited array of action possibilities for them. Players respond to different sets of affordances in specific situations. A progression in their levels of expertise is highly bound to their having had the relevant experiences and practices needed to refine their ways of responding to the salient aspects of situations in particular domains and contexts.

Accounts of cognition that make use of the notion of affordances assume that perceivers are only ever actively sensitive to ambient information in the environment. But this need not be conceived of as a matter of literally taking such information into their minds-brains. For proponents of more radically embodied, enactive and ecological accounts of cognition – those that break faith with representational theories of mind – it

[3] There are other related cases in which commitment – even if only tacit – to traditional assumptions about the mind and how it relates to action impose a strong, an apparently negative, constraints on thinking about training methods. For example, there is experimental evidence in sports science, going back to the mid-90s showing that video-based training may yield limited improvements in video-based tasks. Williams, Ward, and Chapman (2003) used video simulation training in field-hockey goalkeepers in penalty-flick situation and concluded that the group who received the perceptual training improved their response times significantly (when compared to control and placebo groups). They also concluded that such training effect on anticipation skills had transference from the laboratory to the field, highlighting the practical application of the program. Apart form this one study, it has not been shown that such improvements actually transfer to on-field performances. Nevertheless, there has been a widespread adoption of this training practice over the past two decades. Why? This cannot have been driven solely by the, rather weak, empirical findings. Rather, it would appear, that adoption of this approach to training makes sense to those who accept a framework for thinking about cognition according to which perception and action are strongly separate, and according to which decision making is really a matter of forming in-the-head representations (see Dicks et al. 2014 for a full discussion). This case serves as a salient reminder that even though embodied cognition is not news to those working in sports science, it matters for practice which theoretical framework one adopts in understanding how cognition is embodied. What this case underlines is the importance of making explicit the relevant connections between framework, theory and practice.

simply makes no sense to ask 'how, in perceiving, is information literally combined and fused?'

At this juncture it might appear that there is reason to steer clear of Beilock's cognitivist commitments and to endorse the more familiar Dreyfus-style explanation of the acquisition of expertise. That model assumes that skilled expertise – although initially installed by means of following explicit instructions – ceases to be grounded in the explicit following of such instructions once it is fully up and running. It eschews representationalism because it assumes that, once fully established, expertise does not depend upon any kind of mental gymnastics that involves the explicit manipulation of rules and representations at any level. Once experts have properly mastered their skills they no longer rely on articulable knowledge: at that stage they know how and what to do practically, they have become non-representationally responsive to salient features of relevant situations. Engaging with the world expertly is thus a matter of 'absorbed coping' – it is a sort of embodied engagement with the worldly offerings that is of a decidedly non-representational character (Dreyfus 2002). In this the Dreyfusian conception of the embodied basis of expertise sets its face firmly against representational theories of mind. It regards the process of acquiring expertise as involving not only a transition from the explicit to the implicit but also, crucially, as involving a transformation of our modes of dealing with the relevant domain: a switch from representational to fully non-representational, purely embodied and enactive modes of engagement.

Dreyfus and Dreyfus (1980) put forward a five-stage model of skill acquisition, holding that when we are first instructed in how to execute a skill we decompose it analytically into its parts, where each part is explicitly represented and expressed as a rule. Over time novices start to embed their skills, little by little they forget about these rules, they forget how the skill decomposes, and thereby come to perform the skill in automatic mode. Choking can be brought on when, at some later stage – long after this learning process is complete, an expert tries to recall and explicitly attend to the specific rules for executing their skill (if they should try to analyse the parts that compose the skill) they put their performance at risk. Accordingly, on this explanation, when experts attempt detached analysis of what they are doing they disengage from, interfere with, and disrupt the smooth running of non-representational routines that comprise their expert embodied activity. Stepping back from their engaged interactions results in their degraded performance. Choking occurs when one explicitly represents and gives attention to the component features of one's own performance, during its execution.

Despite ultimately emphasizing the absorbed, non-representational – engaged and embodied – character of absorbed coping as the endpoint of the process of mastering and deploying expert skills. Dreyfus' depiction of how we come by expert skills also paints a peculiar and overly intellectualist picture of the situation of novices during the initial stages of skill acquisition.

The Dreyfusian linear model of primary skill acquisition for expert training is conceived of as an ideal step-by step progression based on close pedagogy where repetition of the ideal solution of the technique is fostered. Such training is typically thought to involve the following steps:

- First, break the technique down into a sequence of ideal actions and rules.

- Then, learners should progressively master each of these actions piecemeal and gradually concatenate them into a smooth overall performance.
- Little by little, the explicit rule fades into implicit, automatic absorbed coping.

Although some training regimes may take this form, there is no reason to suppose that they inevitably or necessarily must do so – and there is even less reason to think they ideally should do so. Training novices in line with this didactic, explicit learning model is likely to have the unfortunate consequence of putting them at risk of choking when they are faced with demanding situations in their mature performances. But there is no reason to think such styles of training are unavoidable.

For example to reduce the risk of choking, Masters and Maxwell (2002, 2004, 2008) have argued in favour of so-called 'implicit learning' techniques – those that avoid the use of overt rules and direct instruction – over strategies of explicit learning (see Fig. 1). Implicit learning is meant to avoid the effect of 'reinvestment' (which is a close cousin to the kind of reflection on practice that can result in choking). Reinvestment disrupts relatively spontaneous embodied activity when trying to control such activity in a conscious, explicit way by means of rule-based knowledge, using working memory: such attempts at control are accompanied by a higher degree of self-consciousness during the execution (Liao and Masters 2002). Indeed, with respect to choking, Maxwell et al. (2006) showed that there was a direct correlation between high use of explicit rules in training and decreased performance under pressure.

A range of tactics can be used in order to avoid reinvestment. For instance, Masters (1992) proposed using a secondary task while learning the target task: e.g. verbalizing letters in an aleatory way while learning the golf putt. Another strategy, again for golf, proposed by Maxwell et al. (2006) was to generate a learning process without errors (going from the easiest to the most difficult task). In this fashion, they prevented learners from developing explicit knowledge since this training was not based on forming explicit hypotheses about what was or was not working in the execution of these tasks.

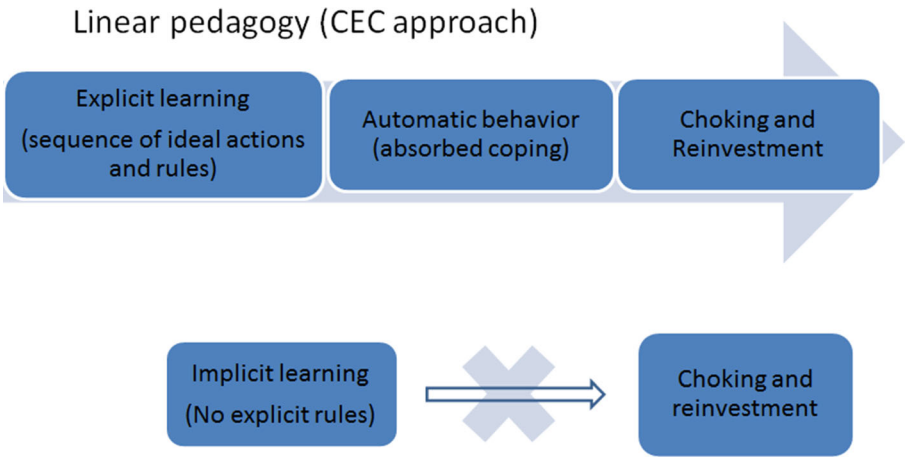

Fig 1 A linear pedagogy. The use of certain forms of explicit, contentful learning promotes to choking and reinvestment. Strategies of implicit learning reduce that risk

Another successful tactic that Masters (2000) advocates is the use of analogy-based learning. The use of analogies in training reduces the risk of attempted reinvestment under pressure conditions because 'metaphors' convey only loose guidance about the relevant movement patterns. This combats the use of explicit, detailed instructions of the sort that overly restrict the exploratory behavior of learners. Lam et al. (2009) showed that basketball throws were less impaired under pressure conditions when the skills in question were taught by analogy-based learning (using the instruction 'Shoot as if you are trying to put cookies into a cookie jar on a high shelf' p. 344) as opposed to training that employed explicit instructions on the mechanics of the throw. Responding to 'biomechanical' metaphors requires each learner to determine how to form shapes with their limbs that accommodate and adjust to the general spatial direction and orientation required by the task. For example, Liao and Masters (2001) showed how table tennis strikes were improved when learners were asked to imagine a right angle triangle (hypotenuse facing up) with the racket hitting the ball when the racket passed the hypotenuse: similar results were obtained by Law et al. (2003).

Miller (2010) describes three different strategies that use metaphorical instructional blends for teaching rowing technique: (1) blending with movements found in other sports or everyday activities ("reach forward like you're passing someone a cup of coffee"); (2) blending by appeal to familiar shapes, motion paths or force-dynamic gestalts ("draw a long rectangle with your hands"); and (3) blending with reference to familiar perceptions, feelings or sensations ("when the oar enters the water, it should sound like an overripe tomato hitting the pavement from ten stories up"). According to Miller, one of the main criteria to create a good instructional blend is that it inspires, through its chosen image, movements with the same structure of dynamic forces as required for the execution of the action.

2 A radically different take on skill acquisition

What kind of cognitive capacities might novices be employing when mastering skills without relying heavily on explicit instruction? A Radically Enactive, Embodied account of Cognition, or REC short, provides a thoroughly de-intellectualized way of understanding the processes involved in 'implicit' and, even, 'analogy-based' learning. This is because REC accounts characterize the most fundamental forms of cognition as a kind of organismic activity that occurs in the form of sensitive interactions stretching across the brain, body and environment (Gallagher 2005, 2008; Thompson 2007; Chemero 2009; Keijzer et al. 2013; Hutto and Myin 2013). Originally inspired by scientific developments in robotics (e.g. Brooks 1991), dynamical systems theory (e.g. Beer 1998), and ecological psychology (Gibson 1979/1986), fans of REC hold that cognition is literally constituted by embodied activity; an idea that finds philosophical support from the phenomenological, American naturalist and Buddhist traditions of thought. The distinguishing feature of REC approaches is their thoroughgoing opposition to the mainstream view that cognition necessarily involves the collection and transformation of information in order to represent the world. Seeking to move away from the idea that the work of

minds is always that of representing and computing, REC approaches fundamentally challenge traditional accounts of cognition that "take representation as their central notion" (Varela et al. 1991, p. 172).

Speaking in support of this tradition, Hutto and Myin's (2013) account of the way we master our basic manual skills as children provides a useful template for understanding how embodied expertise might be engendered through practice without the need for any explicit instruction. They write:

> Nor, with rare exceptions, is it credible that humans learn how to use their hands … by means of explicit, contentfully mediated instruction, the rules for which only later becoming submerged and tacit. It is not as if the children are taught by their caregivers through explicit description how to grasp or reach for items. A far more plausible hypothesis is that we become handy through a prolonged history of interactive encounters-through practice and habit. An individual's manual know-how and skills are best explained entirely by appealing to a history of previous engagements and not by the acquisition of some set of internally stored mental rules and representations. This looks, essentially, to be as clear a case as any of a process of "laying down a path in walking, or, in this case, 'handling'" (Hutto and Myin 2013, pp. 46–47).

Supporting this general line of thought, Davids et al. (2008) claim that even "most complex movement routines involve some elements of fundamental movement patterns that are explored only in infancy, including grasping, gripping, hitting, intercepting, stepping, postural control, balance and locomotion" (p. 87). Explaining how different capacities for basic or fundamental movement patterns become integrated into more complex repertoires is at the core of a REC-based explanation of how some embodied skills are acquired without the aid and internalization of explicit instructions.

In developing a more nuanced account of embodied expertise REC finds its natural partner in ecological-based approaches to the study of skill acquisition, those which build on Gibson's ecological psychology. Gibson's (1979/1986) critique of the information-processing computational paradigm take to heart (that understands perceiving as the receipt and further manipulation of informational contents), embracing an alternative account of perceiving, according to which it is a matter of responding directly to the information in the optic flow and invariants related to the animal. For Gibson there is a tight functional fit between animal and environment without the need to posit mental representations in further cognitive processes (what Chemero 2009 calls 'mental gymnastics') in order to find meaning in the environment.

On this model, individuals are always interacting with their environments in dynamic, informationally sensitive ways. Accordingly, perception and action are not conceived of as separate cognitive faculties but are rather deeply intertwined. Skilled expertise of a radically embodied, enactive sort emerges through processes of continuous interaction between individuals with certain abilities and their surrounding environments, where features of the latter are perceived by the individuals as opportunities for action (affordances).

The great advantage of the ecological paradigm over classical cognitivism is that it shifts the primary unit of analysis from that of the inner workings of the isolated individual to the indissoluble pair of individual more "representative design"

(Brunswik 1956) – one that enables investigation of skilled activities and games (Araújo et al. 2007). The basic Gibsonian approach has been significantly enhanced in recent years by adding the resources of dynamical systems theory (for a developed statement of this view see Chemero 2009). This augmentation opened the way for investigating complex self-organizing dynamics of subject-environment systems in sport and physical activities – a program which currently trades under the name of 'ecological dynamics' (Travassos et al. 2010; Vilar et al. 2012).

According to Chemero (2009, p. xii), a Gibsonian epistemology and metaphysics fits perfectly with a dynamical systems stance on methodology. We would add, in the same vein, that the REC epistemology and metaphysics also fits perfectly with a dynamical systems methodology.

Dynamical systems theory conceives of sporting events in terms of a number of variables that change pattern in a continuous, diachronic and interdependent way according to unfolding laws that can be expressed in mathematical equations. The laws of the theory try to convey the dynamics of the non-linear couplings that emerge between subject and environment in a formal and principled way (García-González et al. 2011, p. 652). Thus, the basic unit of study for ecological dynamics is the nonlinearly coupled animal-environment system. Embodied skills are acquired and emerge as a consequence of a history of interactions between learners and the environment (Chow et al. 2011; Davids et al. 2008). REC processes are essentially interactional and dynamic. Fundamental forms of cognition – attention, perception, making on-the-fly adjustments – are processes that emerge from and within these dynamic interactions (Araújo et al. 2009). Importantly, such dynamic interactions are affected by different constraints (Newell 1986). (See Fig. 2). This idea has been pivotal in the development of the constraints-led perspective on learning based on a non-linear pedagogy.

Non-linear pedagogies, based on a constraints-led perspective, depart fundamentally from this type of approach (Davids et al. 2008; Renshaw et al. 2010; Davids et al. 2012; Button et al. 2012; 2013). From this perspective learners are regarded as dynamical systems with self-organization properties. The aim of training is to attain new functional coordination patterns when interacting with the surrounding environment. As Davids et al. emphasise "from a constraints-led perspective, we can characterize skill acquisition as a learner (a dynamical movement system) searching for stable and functional states of coordination or attractors during a goal oriented activity" (2008, p. 82).

On this view, allowing for variability and openness in the training of skills is to be encouraged. This runs contrary to the idea that skills are best learnt by modeling the

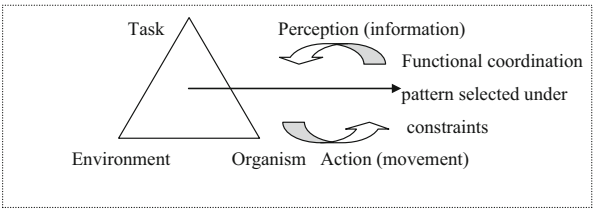

Fig. 2 Ecological dynamics on a model of constraints (adapted from Araújo et al. 2004)

training steps on already well-established if not ideal technical solutions to the tasks at hand. This idea pervades traditional linear pedagogies that see variability as noise or error. From a non-linear perspective what learners need is enough flexibility to adapt to rich and diverse performance contexts.

Solutions for dealing with novel tasks can be promoted through the manipulation of suitable constraints. In a study of emergent behavior in boxing research, Hristovski et al. (2012) discovered that a novel action (back-fist punch) emerged when exploratory behavior was boosted by altering certain task constraints, for instance by moving the punch-bag laterally. Creative performer-environment systems afford new possibilities for action. The learner's ability to adapt to novel problems depends on their capacity to bring their previously acquired repertoires, acquired in previous exploratory behavior, to the new context. As Davids et al. (2008) observe, "positive transfer occurs when a functional coordination pattern (attractor) that already exists in the landscape is functionally adapted for another task, rather like a multipurpose tool" (p. 86). Thus, a non-linear pedagogy encourages change and adaptation in learners instead of trying to structure the training by appeal to a fixed, correct solution or model.

Fostering innovative, creative ways of solving problems is a main feature of what Bernstein (1967) calls 'dexterity'. Dexterity is achieved by solving a problem again and again with relevant variation ('practice is repetition without repetition'). In this fashion, stability and adaptability, the landmarks of true expertise, are achieved. That is why from a non-linear pedagogy, the encouragement of change and adaptation during learning is key; what must be avoided is training for an overly narrow, idealized solution.

Consider the much-discussed question in the skill acquisition literature: where best to direct learners' attention? Where should learners be oriented during training and performance? What is the right focus for their attention – features of the surrounding area, attendant sensations, effects or outcomes? Basically, this debate divides the possibilities into two main types, internal foci of attention (e.g., one's own movements and actions) and external foci of attention (e.g., the tools and effects of one's actions). The main conclusion reached so far is that providing instructions and feedback which direct learners towards external as opposed to internal foci is more beneficial for learning. Such a hypothesis has been successfully tested in: a balance task (Wulf et al. 1998); golf putting (Wulf and Su 2007); tennis backhand and striking accuracy (Maddox et al. 1999); volleyball serves (Wulf et al. 2002); soccer kicks (Wulf et al. 2003); basketball free throws (Zachry et al. 2005); discus throwing (Zarghami et al. 2012); and swimming crawl stroke (Stoate and Wulf 2011). These studies are qualified by the findings of Castaneda and Gray (2007), Uehara et al. (2008), and Lawrence, Gottwald, Hardy, and Khan (2011) who have shown that the capacity to focus fruitfully on external or internal points of attention depends highly on the level of expertise of subjects.

From the vantage of ecological dynamics, there is reason to suspect that the internal-external dichotomy is too simple in any case. It is better to think more neutrally in terms of different attentional anchors – these are pivots related to various other points in a wider dynamical system. In an interview on skateboarding, Rodney Mullen (2002), known for his technical innovation in the sport, provides a useful example of a dynamical attentional anchor:

> So you have these motions that you know in your head … I know what a flip feels like. But what actually will make the trick for you is … finally you pack all

> the stuff for granted [sic] and forget about it and you are focusing only on … or I am at least … you are focusing on only one aspect of where my eye is and my back shoulder is at … at the time I see the edge of the table and then everything else is taken for granted and runs auto pilot. But as long as I can control that one and get a good nose with it from the start, I've got it, and that's how it works for me. Stack, stack, stack, stack, stack, bracket, put like a table cloth over and focus on this last little bit and that's what does it.

In this case the attentional anchor of his focus is a feature of where the eye and back shoulder connect when he sees the edge of the table. Mullen is dynamically relating to internal and external points of attention at the same time – and a specific moment in time. Apparently, he is paying attention to key relational points in the coupling of his individual-environment system. This example makes no sense if we insist on the classical, static and exclusive distinction between external and internal foci of attention. Performers use attentional anchors to reduce their degrees of perceptual freedom (Savelsbergh et al. 2004). Reducing the degrees of freedom in appropriate ways is the outcome of a successful process of skill acquisition. Thus the kinds of attentional anchors one can focus on will depend heavily on one's level of expertise. The attentional anchors Mullen focuses on when skateboarding would not be appropriate for a beginner in the sport – for someone who has yet to master the dynamics of easier situations.

What are the main assumptions of the constraints-led model used in non-linear pedagogies? Primarily that the relevant dynamics, when performing in contexts or when learning a new skill, are constrained by key features of the performer–environment system. Following Newell's (1986) conceptualization of such constraints, we can differentiate organismic, environmental and task constraints.

Organismic constraints refer to those properties of the individual such as weight, height, and body shape as well as cognitive and emotional attributes. One of the principal challenges for organisms is to delimit the tenable patterns of movement from the full range of possibilities for movement. Environmental constraints are external to the individual and can be understood in terms of the affordances and ambient information to be responded to in the environment. Task constraints include the goals of an activity, the norms and rules that govern it, and the tools available and used for performing it.

From a constraints-led perspective, teachers and trainers adopt a strategy of a relatively 'hands-off' discovery-based learning. Still, training is structured in certain ways: trainers provide some constraints to encourage learners' exploratory behaviors so they can find their own individual solutions to the task at hand. Such constraints can be introduced by: changing rules or conditions of the activity or task; changing – e.g. restricting – the space; modifying the equipment; increasing gradually the complexity of the task or simplifying it (Davids et al. 2008, pp. 161–7). The main purpose of these adjustments to the various constraints is to provide enough variability for individual learners to find their own solutions in different situations. The point is that these trainers should not be attempting to get learners to imitate the exact, correct technique but provide support and guidance that appropriately aids and fosters the exploratory activities of the learners (Davids et al. 2008, p. 144). The same applies to verbal instructions: it is no use giving precise instructions and detailing all of the steps composing an idealized technique. Verbal communication should be used to direct the learner's attentional focus and to convey looser and more general ideas about

appropriate actions and movement patterns so as to facilitate self-organized coupling processes (Davids et al. 2008, pp. 178–180).

Relating a constraints-led approach to training to a REC approach, the types of pedagogical and training strategies described above can be understood as employing different kinds of scaffolding. We can distinguish between (a) scaffolding that is not representationally mediated (for example the direct adjustment of environmental conditions or certain task constraints) and (b) scaffolding that involves contentful representations. The former sort of scaffolding aims to promote skillful responding by encouraging the sort of exploratory behavior that boosts the flexible mastery of skills. Learners' skillful repertoires are extended as they find new ways of coupling with the environment through enactive, embodied engagements that involve no representations.

Some forms of scaffolding mentioned above do make use of contentful representations. Yet, as already noted, from a non-linear pedagogical perspective, the use of these representations does not take the form of conveying a set of rules derived from idealized models for performing a skill. Rather, representations should be used to direct "the learner's attentional focus to facilitate self-organized processes" (Davids et al. 2008, p. 178). There are various ways this can be achieved. We already discussed two kinds of representational scaffolds that provide guidance concerning (i) methods or technique (conveyed by analogies and metaphors) and (ii) attentional anchors (that advise learners where to pay attention). We could add a third one: (iii) attentional strategies that advise learners how to pay attention and are related to the search patterns used by players (see Wood and Wilson 2011 for a review of the literature on visual search in sport). Importantly even though these training techniques make use of representations the scaffolding strategies they employ have the express aim of enabling learners to improve their non-representational, embodied coupling with the environment.

For example, from the constraints-led perspective defended by REC, metaphors act as an augmented environmental constraint (Newell 1996, 424). Using metaphors as constraints demands an appropriate degree of personal exploratory room while at the same time providing sufficient focus to help facilitate the self-organization of the learner.

All of these cases show that certain forms of scaffolded training, which direct and guide by means of contentful representations, can help the self-organization of the learner, restricting his or her dynamics and helping to decrease the degrees of freedom by providing guidance through the use of metaphor and direction about appropriate attentional anchors and attentional strategies. Nonetheless, we should not lose sight of the fact that the use of representations in such training does not aim at providing instructions on idealized techniques. Individual self-exploratory solutions to skill mastery should be fostered, not hindered.

3 Representational scaffolding: a challenge to REC?

The above considerations clearly show that a purely embodied, non-contentful account of embodied practice cannot tell the whole story about how expertise is acquired. Contentful scaffolding of and reflection on practice plays an important role in developing and deploying expertise. This fits with the finding that sometimes it is important to take a step back before attempting to execute a task, and sometimes doing so can help to prevent a choke (Beilock 2011, p. 38, p. 43). We need to account for the sorts of

preparations that occur in an incubation period (ibid, p. 40). Even in the heat of the moment, at least sometimes, "people also choke when they are not devoting enough attention to what they are doing and rely on simple or incorrect routines" (ibid, p. 7). What this shows is that, in general, it would be difficult to deny that "sometimes attention to details of your skill – or at least to the details of your surroundings – may be necessary" (ibid, p. 248). Does this tell against adopting a REC framework? Does it provide any compelling reason to think that mental contents must be introduced into our explanations of acquisition or execution of embodied expertise? Not at all.

To prevent misunderstanding, it is important to clarify what 'basic' cognition means on a REC account. It is common in the scientific literature to treat 'basic' cognition as if it designates only very low-grade forms of cognition. For example, Beilock (2011) cites experimental research by Helsen and Starkes (1999) that aimed to discover whether "professional football players' basic visual and motor abilities are superior to recreational players' abilities or whether elite players only surpass recreational players when they perform skills specific to the football game" (p. 59). As a matter of interest, no significant difference between these sets of subjects was found with respect to particular 'basic' visual-motor tasks used in the study – viz. tracking an object moving across a screen. It was only when the context was switched to one that was football-related that important differences in performances between those in the two groups began to emerge – for only then did the professional footballers seriously outperform the others.

This highlights that the intuitive notion of basic cognition at work in much of the general scientific literature, at best, only accidently corresponds to the notion of basic cognition used in the REC framework. REC promotes the possibility that there are kinds of mind that lack content, namely that non-representational minds exist. It assumes that such minds are, phylogenetically and ontogenetically, basic. They are the most fundamental kinds of minds. REC also allows that contentful minds exist, but that these are not 'basic' in the above sense. Such minds – or better content-involving modes of cognition – are necessarily scaffolded modes of cognition. From a REC perspective contentful thought is not a feature of all cognition, rather it is a special achievement. Intelligent beings capable of contentful thought will have participated in and mastered established practices – arguably practices involving public representations that depend for their existence on a range of customs and institutions. Participating in such established practices scaffolds content-involving forms of cognition and makes them possible (see Hutto and Satne 2014).

The result is a complex taxonomy. There are many ways that basic minds can be scaffolded – not all of them involve representations or representational artefacts, though some do. REC assumes that representational minds are necessarily scaffolded minds. Yet not all scaffolding – not even when it involves forms of enculturation – is necessarily representationally grounded. Nor does every scaffolded mind have representational capacities. Rather, according to the REC way of dividing things up, some high-level, sport-specific skilled responding will count as 'basic' (in the sense of involving only non-representational forms of cognition) even if it has been scaffolded by cultural practices that involve the use of representations. Basic forms of cognition – whether sports-specific or otherwise – are distinguished by the fact that they do not involve or make use of mental contents in the ways implied by representationalist accounts of cognition.

For our purposes it is important to note that despite its rejection of the idea of mental contents the REC framework does not rule out that contentful representations – those at

work in our public practices – might play a crucial part in scaffolding the development of purely embodied skills. What a REC account denies is that mental representations must play any direct part in the execution of such skills.

Some doubt the tenability of a REC proposal. Despite recognizing that classical cognitivism is 'no longer mandatory' Cappuccio and Wheeler (2012) press for a Mildly Conservative account of Embodied Cognition (or Mildly CEC, for short) that disagrees in important respects from the REC account of contentless basic cognition that we propose in this paper. These authors maintain that there are cases of skilled coping in which the involvement of "ground-level representations is not merely possible, but to be expected" (Cappuccio and Wheeler 2012, p. 21). Cappuccio and Wheeler (2012) see basic expertise as a mixed bag – involving both representational and non-representational capacities. They argue that the ground-level intelligence that comprises expertise is, in part, best explained by the involvement of action-oriented representations. Action-oriented representations are 'minimally representational' representations in the sense that "rather than determinately specifying some detailed objective content (knowledge-that) … [they] indicate an open-ended set of possible actions (a kind of under-specified knowledge-how)" (ibid, p. 27).

Insisting on the need for such representations they regard any thoroughgoing non-representationalist account of basic cognition, such as REC, as lacking in the resources to fully account for the complex and subtle dynamics of engaged, skillful coping. Where exactly do REC-style accounts fall short? The full answer provided by Cappuccio and Wheeler (2012) is complicated and we will not be able to respond to all of their challenges in this paper. But one major concern they raise touches directly to the issue of scaffolding. Indeed Cappuccio and Wheeler's (2012) principal example, designed to highlight the need to posit action-oriented representations, is one of contentful scaffolding. They bid us to focus on the sort of tactics King George VI successfully used in order to scaffold and intervene on his overpowering stutter when delivering the immortalised speech that announced Great Britain's entry into World War II. Attending to the details of this case matters since it is meant to help 'seal the deal' for a modest, minimal representationalism. Cappuccio and Wheeler (2012) insist that:

> the defiantly nonrepresentational conception of ground-level intelligence developed and defended by Dreyfus himself, and by others who share his general approach, is ultimately unable to do justice to the distinctive dynamics of background, precisely because that conception, at least partly as a consequence of its representation-shunning character, fails to encompass the particular, transformative, background-involving embodied capacity so strikingly illustrated by the King's routine (p. 14).

On standard construals, background capacities are those that serve as preconditions for, enable and make possible other more explicit judgements, states of mind and activities. So what exactly do Cappuccio and Wheeler have in mind when they doubt that a purely non-representationalist account can do justice to transformative background-involving capacities in the King's case? Certainly, there can be no doubt that the King's prepared and practiced routine for controlling his stutter involved a great deal of scaffolding by means of public representations. By all accounts this took the form of a prolonged analysis and diagnosis of his stuttering problem and the particularities of the King's case. This was not something that happened in the moment but over a very extended period of time. Moreover,

these preparations were initiated with an explicit and clearly articulated goal in sight – a goal known to all involved. With the support of his therapist (and later, friend) particular embodied tasks and techniques were recommended, explored in practice and tinkered with so they could be eventually brought to bear in the moment, enabling the King to perform so remarkably on the day.

The important question is this: What kind of representations were involved in this scaffolding? Ordinary, bog-standard, fully articulable and utterly shareable, out-in-the-open linguistic representations, it seems – namely, representations expressed in language and other public mediums. There is no hint – at least, by examining the details of this example alone – that special kinds of sub-personal, action-orientated representations were involved. If action-oriented representations did enable the King's performance then this would have been news to the King and everyone else who helped him to prepare him for his speech.

But if the public representations the King and others used to scaffold his performance were not of the sub-personal action-oriented sort does it follow that they must have been of the 'fully decontextualized', 'present-at-hand' variety – must they have been representations that "encode properties that are essentially action-neutral, specifiable without any necessary reference to the representing agent, and context-independent" (Cappuccio and Wheeler 2012, p. 26). Hardly. The linguistic representations that would have been in play – the various observations, recommendations and imperatives that in the end influenced the King's performance – will have been focused on the King's situation; they will have been of great concern to the King; they will have directed his actions in a non-neutral way; and so on.

Reflection on the details of the King's case reveals that, pace Cappuccio and Wheeler (2012), there is no conflict in accepting both that (1) non-representational forms of absorbed coping are developmentally primary, basic and fundamental and that (2) it is possible to representationally scaffold activities so as to prepare for and intervene upon performances in transformative ways. It is possible to accept both (1) and (2) just as long as one allows that contentful representations exist and can scaffold and influence performances but they are not basic in the sense of forming part of or being involved in most fundamental forms of cognition, just as REC recommends.

Of course, observing that there is no inconsistency in holding (1) and (2) together is not an argument that we should jointly endorse both claims. Yet the only point we want to underscore here is that for all its suggestive power the case of George VI, by itself, casts no doubt on a REC-style account of the non-representational roots of embodied expertise.[4]

Focusing on the King's case should not mislead us into thinking that all forms of scaffolding need be representational and linguistic. As Sutton (2007) observes:

[4] This line of general reply also works when it comes to making sense of Sutton's (2007) analysis of expert batting in cricket, cited by Cappuccio and Wheeler (2012, pp. 23–24). Sutton writes "good players will be constantly resetting their response repertoire in ways which may have been discussed or partly planned out in advance, either deliberately or simply as the result of the sedimented history of relevant experience … One successful case was when, during the one-day internationals before the 2005 Ashes series, Andrew Strauss set himself more than once to get way across to the offside, outside the line of good-length balls from Jason Gillespie and use the pace to lift them over fine leg, a shot unthinkable in less audacious circumstances" (Sutton 2007, p. 775). It would seem that in cases (such as the one described) the representations that are being deployed by skilled athletes are decidedly not of the inaccessible subpersonal sort. Nor are they lacking in objective content. Rather they appear to be linguistically contentful representations of the kind that can be readily expressed and shared with others.

> individualized 'pre-ball routines' as the batsman prepares and takes guard act … as a transportable sequence of consistent and comfortable signs which prepare the mindful body for action (Sutton 2007, p. 774).

There is, however, no need to introduce action-oriented representations into the story in order to explain how such routines might play a part in influencing performance. In general there is no need to appeal to representations in order to explain how we are responsive to naturally occurring signs – understood liberally to include "any situational element" (Cappuccio and Wheeler 2012, p. 25) – might prompt switching from one set of appropriate contextual embodied responses to another set during the flow of activity. As ever, there are non-representational ways of explaining the basis of such responsiveness. It is perfectly possible to understand sign-based responding in wholly content-free, non-representational ways (for details see Hutto 2011, 2012 and Hutto and Myin 2013 – especially pp. 78–82).

4 Is radically embodied expertise mindless?

Does adopting REC, rather than some version of CEC, somehow fail to make proper room for the idea of genuinely embodied intelligence? Does opting for a thoroughly non-representational REC approach somehow render embodied expertise mindless? It may be thought that REC has such implications if it is too closely associated with Dreyfusian thinking about embodied expertise. According to the Dreyfus model choking occurs when there is a break in absorbed coping. Officially, this happens when explicit, conscious cognition interferes with responses that are at best only automatic, implicit, unconscious – embodied responses that involve no mindfulness. That, anyway, is Dreyfus's official line. But to understand the nature of expert minds in such a way has been criticized for systematically neglecting and obscuring the fact that skilled coping is actually a form of "highly disciplined mental activity" (Sutton et al. 2011, p. 78). Certainly, pace Beilock and Dreyfus, absorbed coping is a far cry from merely 'automatic' responding (Sutton et al. 2011, p. 95).

Diagnosing the tendency to characterize skillful embodied coping as mindless, Sutton et al. (2011) regard it as an unwarranted "over-reaction to intellectualism" (p. 79). These authors hold, as do we, that the lure of classical rules-and-representation cognitivism, which they brand 'ultra-cognitivism', should be resisted (p. 87). At the same time, in doing so, we must resist and guard against an equally attractive but wrongheaded "unnecessarily anti-psychological tendency" (ibid, p. 79). We must avoid buying into a crude mind/body dichotomy that merely reverses the standard values so that expert coping is thought of as embodied but essentially mindless (ibid, p. 90). The lesson is that in avoiding one familiar brand of intellectualism one must be careful not to fall into the error of mischaracterizing "what mindedness must involve … lumbering it with heavy duty computational and individualist baggage which a more dynamical, fleet-footed, improvisatory, collaborative conception of the psychological can jettison" (ibid, p. 79).

In contrast to the standard cognitivist picture of cognition, it is possible to accept that "the kind of mental operations in question are not reflective or considered deliberations, not intellectual instructions sent to the body, and yet they are in the realm of the

psychological, both complex and mindful" (Sutton et al. 2011, p. 78). We wholeheartedly agree that this is an important corrective. Undoubtedly what must be resisted are "anti-psychological approaches in which awareness, attention, and memory are entirely evacuated from the skillful body" (ibid, p. 79). Sutton et al. (2011) are surely correct that between the two extreme poles of explicit, contentful deliberate thought and merely automatic, fairly mindless bodily reflexes lies a "rich unexplored space" (p. 81).

Recognizing that embodied, enactive accounts of cognition provide the required framework for 'a live research programme' for exploring this fertile terrain, Sutton et al. (2011) maintain that "central forms of flexible and adaptive action which are clearly not the product of deliberation or explicit reflection can nonetheless be best understood as involving certain sorts of (dynamic, embodied) intelligence" (p. 79).

Illustrating this, Sutton et al. (2011) provide a wonderfully revealing example of mindful expert coping in action:

> An elite cricketer, for example, with less than half a second to execute an ambitious cover drive to a hard ball honing directly in at 140 km/h, draws not only on smoothly-practised stroke play, but somehow also on experience of playing this fast bowler in these conditions, and on dynamically-updated awareness of the current state of the match and of the opposition's deployments, to thread an elegant shot with extraordinary precision through a slim gap in the field. It's fast enough to be a reflex, yet it is perfectly context-sensitive (p. 80).

Considering the details of this sort of case, Sutton et al. (2011) conclude that, "this kind of context-sensitivity … requires some forms of mindedness … [because these are] open skills, where salient features of the environment are tracked and accommodated in an ongoing manner" (p. 80).

Yet again this verdict seems wholly right. Does this in anyway tell against REC in favour of some version of Mildly CEC? Not at all. For in unpacking the nature of embodied mindedness we must take care to keep two ideas quite separate. On the one hand, we have the idea that (1) embodied coping is a form of mindful cognition: on the other hand, we have the idea that (2) mindedness – even in fully embodied, enactive forms – must involve the manipulation of informational or representational contents of some kind.

REC fully endorses (1) while steadfastly denying (2). The REC proposal about basic, non-representational cognition promotes the possibility that there can be genuinely intelligent yet contentless cognition while rejecting any attempt to equate such skilled coping with mindless, unconscious and merely automatic responding.

5 Choking RECtified

In sum, from a REC perspective, choking is not best explained as involving a simple transition in skilled performing from automatic to voluntary control; from implicit to explicit rule-following; or from mindless to mindful responding. A REC account of choking breaks faith with and challenges standard assumptions that ground the current debate on skill acquisition – assumptions that have kept discussions blocked by offering a false, forced choice between the contrasting, opposing pairs of mindless coping or content-involving coping.

From REC's vantage, we can understand choking from another angle. It is not that choking happens when mind and cognition is introduced into the embodied mix. Basic minds imply cognition, but not all cognition implies mental contents or representations. Choking is a disruption that results from badly executed, contentful engagements with more basic forms of embodied mindedness – engagements that upset otherwise successful couplings of the organism-environment system. As we have seen the problems in this domain can often be traced back to conditions under which the skill is first acquired.

This does not license the conclusion that using explicit representations to scaffold performances is always a bad thing. The King's speech scenario shows there are cases in which contentful representations can helpfully scaffold and enable skillful performances, fostering better couplings with the environment when performing an action or executing a technique. Nevertheless, representationally scaffolded practices that boost disengagement with the environment are not ideal for the development of embodied skills. Traditional, linear pedagogical strategies that employ overly precise and detailed explicit instructions about the sequence of movements and actions are precisely those to be avoided. That is the sort of training that promotes the possibility of choking when performing under pressure.

Employing contentful scaffolding of the appropriate kind during initial training can reduce the risk of choking. Scaffolded training that generates more flexible modes of coupling with the environment when mastering a technique should be preferred.[5] Taking into account what we have said about a constraints-led perspective, there already exists a good selection of suitable training devices that can help learners to adapt to novel situations. The best way to avoid choking in practice is to RECtify standard thinking about enactive expertise, scaffolded training and embodied skill acquisition.

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[5] So far, we have been talking about technique. Nonetheless, if we would like to pay attention to tactical behavior in a game, there are scaffolded practices that could help as well. During the game, players face technical/tactical situations to solve continuously. Nonetheless, the situations they face are constrained by strategy that is referred to: (i) system (e.g. 4-3-3 in football); (ii) style of playing (attacker, counter-attacker, defensive); and (iii) game plan (e.g. 'firstly you should make him tired and then push his weak points'). Such strategic elements are instantiated, maintained and/or varied in real time by the interaction with the coach (giving instructions during the game) and/or in interaction with other teammates.

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