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Attentional Focus in Motor Learning, the Feldenkrais Method and Mindful Movement

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Summary

The present paper discusses attentional focus in motor learning and performance from the point of view of mindful movement practices, taking as a starting point the Feldenkrais method. It is argued that earlier criticism of the Feldenkrais method (and thereby implicitly of mindful movement practices more generally) because of allegedly inappropriate attentional focus turns out to be unfounded in light of recent developments in the study of motor learning and performance. Conversely, the examples of the Feldenkrais method and Ki-Aikido are used to illustrate how paying more attention to both Western and Eastern (martial arts derived) mindful movement practices might benefit sports psychology.

Keywords

External focus of attention, constrained action hypothesis, self-invoking trigger hypothesis, mindful movement, Feldenkrais-method

Introduction

A considerable amount of work in sports psychology attests to the importance of the choice of attentional focus in movement learning and performance, and in particular to the advantages of an external focus (Wulf, 2013). In another strand of research, inspired by the recent popularity - and evidence for psychological efficacy - of mindfulness and acceptance based approaches, researchers studied mindfulness based interventions in sports (Bernier, Thienot, Cordon & Fournier, 2009; Kaufman, Glass & Arnkoff, 2009; Gardner & Moore, 2012). In contrast to usual psychological skills training, the latter interventions aim at changing the relationship to one's inner experiences (thoughts, emotions, etc.) rather than the experiences themselves. In this context one should notice that this aim was already present not only in many “Eastern” *mindful movement* practices (e.g., traditional martial arts, compare Ilundain-Agurruza, 2015), but also in some “Western” somatic practices (see below).

Given that mindfulness is widely defined as a particular way of paying attention (Baer, 2003), one might expect considerable overlap between these areas of research. Yet, surprisingly, few studies seem to connect them. One point of contact was made already several years ago, before the recent explosion in mindfulness research, when Buchanan and Ulrich (2001) described the Feldenkrais method (a “Western” form of mindful movement) in a tutorial and argued that it deserves scientific scrutiny as a method of changing motor behaviour and function. This was criticized by Ives (2003)

because of perceived lack of evidence for “physiological” changes in performance due to practising the Feldenkrais method, which in turn was explained by alleged internal, hence inappropriate, attentional focus as well as assumed overemphasis on kinesthetic training.

Recent developments, both in the study of the effects of attentional focus and the efficacy of the Feldenkrais method, merit a new look at the relationship between the Feldenkrais method, attentional focus, and mindfulness. The present paper will argue that external focus of attention is an important part of motor learning in the Feldenkrais method, and further that other features of the method are linked very well with the most popular explanation for the usefulness of an external focus of attention: the constrained action hypothesis (McNevin, Shea & Wulf, 2003). Finally, some speculations concerning relations to mindful movement practices will be presented, using the example of the martial art of (Ki-)Aikido.

Background

Attentional focus and motor learning

Work in motor learning conducted since the end of the 1990s by Gabriele Wulf and others showed that motor performance and motor learning is profoundly influenced by the focus of attention during the movement. Specifically, “an external focus (i.e., on the movement effect) enhances motor performance and learning relative to an internal

focus (i.e., on body movements)”, both in terms of effectiveness and efficiency, as well as whole-body movement coordination, in a wide variety of movement tasks and at different levels of expertise (Wulf, 2013; other reviews include Wulf, 2007; Wulf & Lewthwaite, 2010; Wulf, 2014). Typical instructions are for example to focus on the movement of the club (external focus) versus focusing on the movement of the arms (internal focus) when practising golf (Wulf, 2007, p.43), or, when balancing on a platform, focusing on the feet (internal focus) versus focusing on markers near the feet on the platform (external focus) (ibid p.41f). Interestingly, in the latter case balance improved even more with markers in the middle between the feet as well as with markers farther out to the side, compared to markers at the feet (ibid p.68&69). Another interesting observation is that the advantages of external focus seem to show themselves mainly in learning *tasks* that the learner finds difficult (ibid p.129). On the other hand, more complex and hence demanding *instructions* might eliminate the advantages of an external focus (ibid p.130ff): “Overall, these findings suggest that external focus instructions are best limited to one cue at a time. This is especially true for novices, who might otherwise be easily overwhelmed by the amount of information [...]” (ibid p.133).

A suggested explanation for the advantage of an external focus of attention is the *constrained action hypothesis* (McNevin, Shea & Wulf, 2003), which holds that an internal focus of attention might interfere with automatic processes that control

movement in that it “constitutes a conscious intervention into control processes that would ‘‘normally’’ regulate movements effectively and efficiently” (Wulf, 2007, p.114), whereas an external focus lets the motor processes self-organize organically (e.g., Wulf, McNevin & Shea, 2001; Kal, van der Kamp & Houdijk, 2013). This can nicely explain the relationship (noted in Wulf, 2007, pp.127-130) between task difficulty and the effectiveness of an external focus of attention - an external focus is more helpful for difficult tasks - since “when the task is relatively simple and the performer is satisfied with the ongoing motor control processes, he or she is not tempted to intervene.” (Wulf, 2007, p.129).

The Feldenkrais method

Moshé Feldenkrais, *ingénieur-docteur* and expert martial artist, developed his method of movement-based re-education, which aims at improving the functioning of the mind-body - which is seen as an inseparable unity - starting in the 1940ies (Feldenkrais, 1949; Feldenkrais, 1981; Buckard, 2015). Feldenkrais saw movement both as a crucial tool for re-education (Feldenkrais, 1972), as well as being constitutive of many if not all of the human functions one might want to improve. In this context, improving movement function can range from simple activities of daily life, through being able to deal with a physical handicap (a major knee injury was one motivation for Feldenkrais to begin his studies), to efficient and effective movement in life-or-death situations (during WW2 Feldenkrais wrote a manual for unarmed combat: Feldenkrais,

2009/1942). In an even more general sense, function is here understood as “the interaction of the person with the outside world or the self with the environment” (International Feldenkrais Federation, 1994, section 1.4). Given the focus on (re-)education and learning, it is customary in the Feldenkrais world to speak of *lessons* rather than exercises or treatments.

The Feldenkrais method is practised in two forms: verbally directed *Awareness Through Movement* (ATM) lessons (Feldenkrais, 1972), usually held for groups, and manually directed – hence necessarily individual – *Functional Integration* (FI) lessons (Rywerant, 2003/1983). The literature on attentional focus in motor learning tends to manipulate the focus of attention via verbal instructions; since this is more comparable to the verbally directed ATM rather than the FI lesson format, this paper will focus on ATM. Nevertheless, it is worth pointing out that the names of the two forms of practice should not be seen as indicative of differences in the two approaches: In fact, in both ATM and FI lessons the goal is to expand awareness through movement (not movement with/through awareness!) and integrating function in the sense of “using the whole self” in it: all parts of the body-mind work together harmoniously and efficiently in performing the function. In a therapeutic setting, Myers (2016) provides a nice example of the interplay of ATM, FI, and physical therapy in the treatment of hip and lumbar pain in a runner with idiopathic scoliosis. The examples of ATM instructions given were typical for what would also be used in a non-clinical setting: take frequent brief

rests to free attention and allow learning to settle in, do not go into pain, do not stretch or find barriers for the movements, identify and reduce effort, and find the lightness and ease of the movement.

ATM lessons were described by Buchanan and Ulrich (2001) as “verbally guided movement explorations in which teachers focus the students' attention on the sensory information that accompany a series of movements [...] teachers primarily direct students' awareness to the exploratory process.” In common with FI lessons, the goal is not only to “enhance people's awareness of their habitual solutions to motor problems and the sensations accompanying those habits, demonstrate other solutions, and help students select easier, more efficient, and more effective movement options”, leading to “more seemingly automatic use” of motor skills, but also to help them learn about the learning process so that they can transfer the learning approach to other settings and thereby “become self-directed learners who can apply the perceptual-motor skills and exploratory strategies teachers believe to be fostered by Feldenkrais lessons to a variety of learning situations.” As an aside, we might notice that such self-directed learning is consistent with the advantages of autonomy in motor learning (see, e.g., Andrieux, Danna & Thon, 2012; Chiviakowsky, 2014) since according to Andrieux et al. “the learner would be most adept at determining the optimal level of task difficulty”, and paying attention to the ease or difficulty that one feels while moving is an essential part of the Feldenkrais approach.

The article by Buchanan and Ulrich (2001) engendered a discussion in the literature concerning the effectiveness and efficacy of the Feldenkrais method (Ives, 2003; Buchanan & Ulrich, 2003; Connors, Galea, Said & Remedios, 2010; Buchanan, 2012). Specifically, Ives (2003) claimed that the evidence at the time of his writing did not justify recommending the Feldenkrais method above other techniques, and further that “any effects noted appear to be psychological and not physiological.” As an example, he pointed to three studies on postural sway following Feldenkrais lessons that reported findings which were both conflicting and of small effect size. Trying to explain this apparent lack of effectiveness, he claimed that “[a]n essential factor in the Feldenkrais Method is its emphasis on self-awareness” and likened this to an external focus of attention, which is inferior to an external focus in motor learning and performance.

Overview of the present paper

In the following I will argue that the critique of the Feldenkrais method based on the alleged internal focus of attention rests on a subtle but crucial misunderstanding of the meaning of “external focus”, as well as of the way the Feldenkrais method is practised: current use of “external focus” and theories for its effectiveness seem to imply that it is well aligned with the Feldenkrais method in particular and mindful movement more generally. Before doing so I will start with a brief look at recent research on the Feldenkrais method in the next section. The following section contains

a more detailed look at attentional focus and the Feldenkrais method, the penultimate section puts the discussion in the context of other mindful movement practices. Finally, an outlook on possible future research and on practical implications is presented.

Current state of evidence concerning the Feldenkrais method

Effectiveness

Buchanan (2012) already stressed that the study of the Feldenkrais method has progressed since the time of Ives' (2003) comment and provided a systematic overview and discussion. Even more recently, the review and meta-analysis (Worley & Hillier, 2015) appeared, based on twenty randomized controlled trials of the Feldenkrais method (not yet including the interesting pilot study on the effects on people suffering from Parkinson's disease by Teixeira-Machado *et al.* (2015), which appeared after the review was published). They were able to perform meta-analyses with seven studies, finding in favour of the Feldenkrais method for improving balance in ageing populations (with effect sizes in terms of Cohen's d ranging from -0.1 to 1.85). This is particularly interesting given Ives' remarks above on postural sway, and the fact that these effects are more obviously connected to motor performance than other claimed effects of the Feldenkrais method may be. The overall conclusion of the review was that “[t]here is further promising evidence that the FM [Feldenkrais method] may be effective for a varied population interested in improving functions such as balance.”

Arguably, additional indirect support for the efficacy of the Feldenkrais method comes from the fact that it is but one of a number of Western somatic education methods (Mullan, 2014), some of which are closely similar to it and also have some support from empirical research. To pick only one example, the Alexander technique is often compared to the Feldenkrais method (e.g., Buchanan 2012, section 4.2), the main difference being that in the Alexander technique the teaching apparently tends to be somewhat more directed: according to Jain, Janssen and DeCelle (2004), "In the Alexander technique, the teacher provides more clear direction to the student, whereas in the Feldenkrais method, the teacher makes a point of not directing toward a specific outcome. " and "In the Alexander technique, the objective is controlled, elegant, functional movement, whereas in the Feldenkrais method, the desire is spontaneous, elegant, functional movement". Recent evidence for the effectiveness of the Alexander method includes Cohen, Gurfinkel, Kwak, Warden and Horak (2015) for balance, O'Neill, Anderson, Allen, Ross and Hamel (2015) for gait behaviour, and Little, Lewith, Webley, Evans, Beattie *et al.* (2008) for back pain. None of these papers reports statistical effect sizes, but the changes (relative to control) in the primary outcome measures of the back pain intervention after 24 months are not only statistically significant but also clinically meaningful: 42% reduction in Roland disability score and 86% reduction in days with pain.

Theoretical basis and basic mechanisms

The Feldenkrais method is a “highly fluid and dynamic method” whose “practitioners/teachers continually evolve their understanding and practice of the Method” (International Feldenkrais Federation, 1994, Preface). Feldenkrais' original development of the method was based on his thorough review of the scientific state of the art at the time (Feldenkrais, 1949), much of which nevertheless has held up remarkably well over time given that this review happened more than half a century ago (Schleip, 2000). Foundational ideas already mentioned above include: (a) movement and posture are seen in terms of function (rather than structure, as often happens for example in physical therapy); (b) since movement is organized by the nervous system, changing motor behaviour is viewed as a learning task (see Klinkenberg (2005) for the relationship between the Feldenkrais method and behavioural therapy); and (c) body and mind are an inseparable unity, hence improving movement affects the whole person. Learning is hypothesized to be most effective when conscious attention is paid to the consequences of slight variations in movements (thereby allowing the nervous system to autonomously select the best way to behave), which in turn will be facilitated by an attitude of open curiosity and a sharpening of proprioceptive and other perceptual skills.

Three recent papers looked at these foundations from different angles: In work using fMRI scanning by Verrel, Almagor, Schumann, Lindenberger and Kühn (2015), a short, Feldenkrais-based sensorimotor intervention - usage of the “artificial floor” - had

effects on cortical activity in functionally related brain regions; whereas Kimmel, Irran and Luger (2015) provide a perspective on the relationship between dynamic systems theory and the Feldenkrais method (as well as Shiatsu) using a micro-ethnographic approach. Support for the idea to use Feldenkrais movement lessons for the re-education of the whole person comes from Clark, Schumann and Mostofsky (2015), who propose a "model of skilled attention in which motor plans, attention, and executive goals are seen as mutually co-defining aspects of skilled behavior that are linked by reciprocal inhibitory and excitatory connections."

Focus of attention and “Awareness Through Movement”

This is the main section of the paper: Remarkably, in recent work a focus on the *quality* of movement was counted as *external* focus. I will argue that, since quality of movement is a main point of attentional focus in the Feldenkrais method, its focus is in large part external. Furthermore, in as far as the constrained action hypothesis and micro-choking are the basis of the advantage of external focus in motor learning, it seems even clearer that the Feldenkrais method should be expected to be an excellent way of approaching improvement of (movement) function.

External focus of attention: recent developments

There seems to have been a subtle shift in the meaning of the expression “external focus of attention”: whereas Wulf, Höß and Prinz (1998) spoke of “attention

on the *effects* of their movements *on the apparatus or implement*—that is, the environment” [italics on “effects” in the original, other italics added], recent work included instructions to direct attention to the *quality* of the movement among external focus instructions. Specifically, Neumann and Brown (2013) had their participants perform sit-ups under 2x2 conditions: (external/internal) x (association/dissociation), resulting in four modes of attentional focus: (a) external and task relevant, (b) internal and task relevant, (c) external irrelevant (e.g., scenery), and (d) internal irrelevant (e.g., daydreams). Best results were achieved in the external association condition. Notably, the instruction for this consisted in “repeating the phrases “make your movements smooth” and “make your movements flow””; thus attention was directed to the quality of the movement. Wulf (2013) also counted this as an external focus of attention. We will see below that including emphasis on the “how” of the movement makes external focus of attention an excellent fit with the Feldenkrais method.

Another relevant recent development are the speculations in Wulf and Lewthwaite (2010), who suggest an explanation of the constrained action hypothesis based on “self-invoking triggers”, conjecturing that internal focus instructions (those which “involve the human body”) provoke access to the self and thereby may trigger *self-evaluation and active self-regulation*, leading to “a series of ongoing ‘microchoking’ episodes with attempts to right thoughts and bring emotions under control”. Negative thoughts and emotions are in turn known to “influence or correlate

with the neuromuscular coordination or control of movement tasks and skills” so that (negative) self-evaluation may lead to less automatic, more conscious and inefficient use of the body. McKay, Wulf, Lewthwaite and Nordin (2015) provide empirical evidence consistent with the self-invoking trigger hypothesis.

This invites further speculation: One role of emotion is to provide information. Positive affect signals a clear path to go ahead with whatever is at hand, e.g., cognitions (Clare & Huntsinger, 2007) or perceptual inclinations (Huntsinger, 2013), whereas negative emotions signal the necessity for change. If this is so, then *positive*, as well as *non-judging* and hence anxiety-free, forms of self-evaluation should give no reason to try to bring thoughts, emotions (or maybe even the movements themselves) under control and hence *not* interfere with automatic movement processes. This has already been noticed in Wulf and Lewthwaite (2010): “It may be that active self-regulatory activities do not ensue, or at least demand less effort and attention, when positive self-regard and optimal task performance are experienced.” As Ilundain-Agurreza (2015) pointed out, important is not only what one attends to, but also how one does so. Viewed in this light, it is not at all clear how different the view expressed in Toner and Moran (2015) really is from the prevailing view about the optimality of an external focus of attention: “careful attention to our bodily means (and attendant feelings) of action” could very well be read as paying attention to the quality of what one is doing, hence an external focus.

Attention in the Feldenkrais method: a closer look

Ives' (2003) claimed that Buchanan and Ulrich (2001) supposedly pointed out that self-awareness has a crucial role in the Feldenkrais method, and that such an (alleged) emphasis is contrary to the literature on goal setting. Presumably, this refers to their discussion of conceivable differences between dynamic systems theory and the Feldenkrais method, where they state, “During a Feldenkrais lesson, emphasis is placed on attending to sensory information present during exploratory movements. Teachers of this method argue that by first improving the sensitivity of perception one can learn to adapt any behavior more easily. Thus, during instruction, the motor goal or task is secondary to the process of improving perceptual-motor skills for subsequent use in self-organizing task-specific behaviors.”

There seems to be a natural but crucial misunderstanding involved in Ives' claim: “attending to sensory information” in Feldenkrais is not the same as putting emphasis on “self-awareness”, in particular not if the latter is understood in the sense of an internal focus on movement of body parts. In fact, attention in the Feldenkrais method consists *both* of a foreground and a background (e.g., Krauss, 2001, p.66; for divided attention in general see for example Moran, 1996, p.48ff) of open, *effortless* attention (compare the articles in Bruya, 2010). The foreground will usually (but not always) consist in the movement exploration undertaken; the background can be other regions of the body, the position in space, the environment, etc. A very clear example of

divided attention is provided by one of the so-called Alexander Yanai (AY) lessons, specifically AY#359 “Tanden with bending the knees” (see Solovay, 1994-2004, volume 8 part A), where attention is divided by directing it primarily to a certain point in the body (the *tanden*, see farther below) and in addition to “the length of the spine, the width of shoulders and arms, the length of the legs, the spreading of the face, the mouth, the exposure of the teeth, and the widening of the area of the eyes [...] such that the face will be able to smile at any moment.” Movements are to be done *only* to the extent that it does not disturb this attention. In the self-explaining terminology of Lutz, Slagter, Dunne and Davidson (2008) popular in the mindfulness literature, the Feldenkrais method is much more similar to *open monitoring* than to *focused attention* meditation.

Crucially, from the very beginning of his explorations Feldenkrais understood that “how [one] did a movement was much more important than what the movement consisted of” (Feldenkrais, 1981). In other words: even for what is in the foreground of attention, the important thing to pay attention to is not considered to be the movement itself but the quality of the movement – that is, an external focus of attention (compare above). Examples of explicit instructions to attend to the quality of the movement can be found in Connors *et al.* (2010, Table 6: 1.3) (even though they classified “quality of movement” under intrinsic feedback, in contrast to the apparent current usage of the term referred to above). In this context, *self-evaluation and active self-regulation* are

precisely what the Feldenkrais work carefully aims to avoid. Thus, trying to do a “correct” movement is explicitly discouraged, in favour of curious and open exploration. As Buchanan and Ulrich (2001) expressed it, “[d]uring *Feldenkrais* lessons, students are not told rules for how to do a movement but are guided to explore action possibilities and attend to the accompanying sensations. The presumption is that they will self-organize behaviors emerging from individual constellations of intrinsic factors in relation to the extrinsic factors posed during lessons.” Examples, from the Alexander Yanai series (Solovay, 1994-2004), of instructions explicitly displaying this kind of guidance include: AY#343 „Do not become involved in the movement.“, AY#310 “Try to organize the breathing, the chest, and the lack of intention to succeed.”, AY#182: “Try it despite the situation being uncomfortable. Organize so that it will be easy to do. That is the essence of the essences – to make the difficult comfortable.”, or AY#035: “saying that you should breathe like this or that becomes a fundamental mistake.” In addition, the emphasis on ease and staying within a comfortable range is consistent with research that shows that measuring oneself against performance criteria that are too demanding is detrimental to motor learning (e.g., Chiviacowsky and Harter, 2015).

Ives (2003) was perfectly right in saying that a “strategy in which focus is placed on internal bodily sensations such as breathing, pain, and muscle tension [...] appears not in harmony with the desired outcomes of Feldenkrais lessons.” Precisely

for this reason, the focus of attention in the Feldenkrais method is primarily on quality and ease of movement, hence external.

Self-evaluation, micro-choking and the Feldenkrais method

Returning to the issue of attention and effort, it is important to point out that “Reduce your effort” is almost a cliché in the Feldenkrais world. In the vast majority of cases, instructions in ATM are to move with ease and comfort (compare for example International Feldenkrais Federation, 1994, section 1.10), and to stay within the range that is comfortable. There are at least two reasons for that: less effort allows distinguishing more subtle sensations, and it contributes to the avoidance of negative self-evaluation during and after the lesson.

Concerning the latter, Feldenkrais (2002/1985) writes that when acting correctly, “the alternative of failure has no compulsive tension about it.” In fact, the lessons should be done in a way that encourages good mood since (ibid p.xxxix): “Learning must be undertaken and is really profitable when the whole frame is held in a state where smiling can turn into laughter without interference, naturally, spontaneously.” Besides moving with ease, a negative self-evaluation is also avoided by slowly building up complex movements from simple parts (compare the remarks quoted above on complex instructions with external focus) and by not declaring an intended outcome of the lesson, thereby encouraging curiosity as well as discouraging

critical self-evaluation that might be caused by observing how far one still is of the intended final movement.

As concerns the issue of effort and sensitivity to sensations, it is perfectly consistent with both the theory and the practice of the Feldenkrais method when Ives (2003) points out that “conscious and focused effort is not required and perhaps not even important to improve perceptual sensitivity”. Feldenkrais (2002/1985) himself wrote that “[t]he keener the watch on resistance, the finer is the skill and competence in the end”; his point is not to sharpen sensitivity in order to enable conscious intervention in movement patterns but rather to be able to notice and then stop obstructing the natural course of movement. Already Buchanan and Ulrich (2001) quoted Feldenkrais as stating that “re-education of the kinaesthetic sense, and resetting it to the normal course of self-adjusting improvement of all muscular activity - the essence of life - is fundamental”. One may or may not agree that it is the essence of life, but “self-adjusting improvement” is precisely what mediates the usefulness of an external focus of attention in motor learning, according to the constrained action hypothesis.

One way Feldenkrais expressed this was using the idea of mono-motivated action (Feldenkrais, 2002/1985, chapters 4&14), in particular of avoiding “parasitic”, unnecessary muscle action – both movement that does not contribute to the function at hand as well as unhelpful stiffness, i.e. lack of efficient participation of the whole self in the function. Wulf (2013) noticed that what Feldenkrais would have called parasitic

muscle action seems again related to an internal focus of attention: “A higher degree of co-contractions of agonist and antagonist muscles with an internal focus was found by Lohse et al. (2011) using an isometric force production task.” More generally, the concept of mono-motivation and its opposite, cross-motivation, fits perfectly with the above mentioned idea that performance deficits under internal focus condition result from the desire to both execute a movement and regulate emotions at the same time – a clear example how cross-motivation interferes with automatic processes.

By the way, it is interesting to note parallels between the Feldenkrais' idea of mono-motivation and psychological research on the relationship between conflicting goals and well-being (e.g., Kelly, Mansell & Wood, 2015; Koletzko, Herrmann & Brandstätter, 2015), in particular in view of the already noted fact that the goal of the Feldenkrais method is not only improved movement but (self-)education of the whole person. Nevertheless, a discussion of this is beyond the scope of this paper.

Summary and preliminary conclusion

To sum up, Feldenkrais “Awareness Through Movement” lessons are characterized by: focus on quality of movements, positive mood and avoiding cross-motivation. If the above quoted speculations concerning the crucial role of avoiding negative self-evaluation and microchoking (Wulf & Lewthwaite, 2010) hold true, this would seem to suggest that Feldenkrais is an excellent approach to motor learning.

The Feldenkrais method in the form of *Awareness Through Movement* provides a treasure trove of experience with the use of attentional focus instructions. In general, proper instruction requires considerable expertise not least because “no pain, no gain” is deeply ingrained in our culture (and, arguably, in the human mind – compare the negativity bias: Rozin & Royzman, 2001), so that it is difficult for many people to adjust to effortless motor learning. Nevertheless, some simple interventions should lend themselves reasonably easily to experimental study. To give just one example: Returning to the study that successfully used “flow” and “smoothness” of movement to improve performance during sit-ups (Neumann & Brown, 2013), it would be worthwhile to try instructions to put attentional focus on the relaxation of the antagonists (back muscles), or more generally on allowing movement in the back. If this results in performance enhancement compared to focusing on the feeling in the abdominal muscles (the internal focus condition in the paper) this would be evidence against the assumption that referring to the body is always sufficient to trigger microchoking (compare above). Of course all this would have to be done with suitable manipulation checks, since an instruction “make the movement smooth” might already make the study participants relax their back muscles (it is hard to make smooth movements while being aware that the antagonists are contracted).

Thus we are back full circle to the work of Buchanan and Ulrich (2001; 2003): the Feldenkrais method deserves the attention of the movement researchers.

Mindful movement

Mindfulness is a hugely successful concept that is widely conceptualized as “the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment.” (Kabat-Zinn, 2003). Evidently, Feldenkrais *Awareness Through Movement* classes are a form of “Mindfulness Through Movement”: one pays non-judgemental attention to the presently unfolding movement experience, rather than trying to follow a prescribed “correct” movement form.

Thus, if indeed non-judging forms of self-observation do not prejudice automatic and hence good movement learning and performance, one would expect this to apply in particular to mindful movement practices. So it should not come as a surprise that, according to Sappington and Longshore (2015), there is “preliminary support for the efficacy of mindfulness-based interventions” for the enhancement of sport performance. Also, mindfulness seems to contribute positively to motor control as Naranjo and Schmidt (2012) found that “mindfulness meditation practice is associated with slower body movements, better motor performance, and enhanced awareness of perceptual-motor conflict” in a visuomotor reaching task with false feedback, and in the work of Kee, Chatzisarantis, Kong, Chow and Chen (2012) state mindfulness induction led to both better performance and more use of external focus strategies (looking at a spot/spots in front) in a subsequent balance task, with a small effect of the brief

mindfulness intervention on performance ($r=0.04$) but a considerable effect on focus ($r=0.4$). Zhang et al. (2016) show in a randomized trial that beginners' dart throwing performance as well as psychological measures improve more for a mindfulness training program (mindfulness-acceptance-commitment approach, MAC) than for an attention control group (i.e., control received sports psychology lectures) with an effect size of $\eta^2=0.33$ for performance.

Connected with choking under pressure, Ilundain-Agurruza (2015) discussed traditional Japanese swordsmanship as a case study of extreme pressure to perform, and in particular the idea of *mushin*: the concept of an imperturbable mind (literally, “no mind”) that is able to uphold fluid attention unperturbed by thoughts and emotions. Practice forms like *Iaido* (the art of drawing the sword) are movement meditation techniques that help attain *mushin* through mindfulness in that “[t]hose trained in these ways are mindfully aware without remaining fixed.” A modern Japanese martial art with deep roots in ancient swordsmanship is *Aikido*; for this art, which Lothes, Hakan and Kassab (2013) called a form of “meditation-in-action”, these authors provided some evidence that its practice increases mindfulness.

This again points to mindful movement as a way to prevent micro-choking. In this context it is interesting that many Japanese (and Chinese) martial art forms emphasize putting the attentional focus primarily on the point in the abdomen called *tanden* in Japanese. This may sound like an internal focus of attention, but one should

notice that the purpose is not to regulate movement but to calm the mind. This is particularly clear in *Shin-Shin-To-Itsu-Aikido* (Aikido with mind and body unified; for short: Ki-Aikido), which is underpinned by four basic principles (compare Tohei, 1996, chapter 2): (a) Keep one point; (b) Relax completely; (c) Let Ki extend; (d) Weight underside. Crucially, these four principles are not really different but rather they are aspects of the same underlying principle: cultivation of keeping the attention at the *tanden* one point (an apparently internal focus of attention) is no different from cultivating the ability to “let Ki extend” away from oneself in all directions (obviously an external focus of attention). This suggests a negative answer to the second of the two related questions posed in Wulf (2013), namely: “Are attempts at controlling body movements the precondition for less-than-optimal performance? Or are simple references to the body able to invoke the self system [...] and trigger self-related thoughts which, in turn, cause micro-choking episodes?” The above speculations suggest one way to deal with the problem: keep (part of) your attention at *tanden* thereby relaxing and letting your attention (“Ki”) extend; thus avoiding micro-choking that would arise from conflicts between (more or less conscious) intentions and automatic processes. This means in Aikido language to “unify mind and body”, or in Feldenkrais *parlance* to “act with your whole self”.

Outlook: Practical implications and further research

Both the research by Neumann and Brown (2013) and the practical experience

in the Feldenkrais method and in martial arts suggest, that the effect of attentional focus is much more complicated than a simple internal/external dichotomy would imply. In line with the constrained action hypothesis, the crucial point is to deploy attention in a way that avoids triggering inappropriate interference with automatic (movement) processes. Depending on circumstances, this may be best achieved by focusing one's attention on an object outside the body, by centering at the *tanden* while at the same time staying connected with the world, by paying attention to the ease and quality of the movement, or by a combination thereof. Many hundreds of recorded Feldenkrais lessons, and the wide variety of traditional or tradition-based martial arts, provide sports psychologists and movement scientist with interesting ways of deploying attention, whose efficacy and efficiency warrant rigorous testing.

Potential areas of application are numerous, as already indicated by the fact that traditional Japanese arts are based on similar principles to the martial arts (Suzuki, 1959), and by the popularity of the Feldenkrais method among performance and other artists (Worth, 2015). Not only can movement learning (in sports, performing arts, physical therapy and rehabilitation) and performance (in particular under pressure) profit from a better understanding of the issues discussed in this paper; but conversely, the interplay between movement and psychological aspects should be useful in relation to well-being (Hefferon, 2013) and psychological health (Klinkenberg, 2005). Concerning the latter it is interesting to note that the so-called "third wave" of

cognitive-behavioural psychotherapies saw a confluence of mindfulness-based (e.g., Mindfulness Based Cognitive Therapy: Segal, Williams, & Teasdale, 2013) and learning-theory based (Acceptance- and Commitment Therapy: Hayes, Strosahl, & Wilson, 2012) methods, in line with the parallels emphasized in this paper between (mindfulness-based) martial arts and the (learning-theory based) Feldenkrais method.

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Potential conflicts of interest

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