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"Introjecting" imagery: A process model of how minds and bodies are co-enacted

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ABSTRACT

Somatic practices frequently use imagery, typically via verbal instructions, to scaffold sensorimotor organization and experience, a phenomenon we term "introjection". We argue that introjection is an imagery practice in which sensorimotor and conceptual aspects are co-orchestrated, suggesting the necessity of crosstalk between somatics, phenomenology, psychology, embodied-enactive cognition, and linguistic research on embodied simulation. We presently focus on the scarcely addressed details of the *process* necessary to enact instructions of a literal or metaphoric nature through the body. Based on vignettes from dance, Feldenkrais, and Taichi practice, we describe introjection as a complex form of processual sense-making, in which context-interpretive, mental, attentional and physical sub-processes recursively braid. Our analysis focuses on how mental and body-related processes progressively align, inform and augment each other. This dialectic requires emphasis on the active body, which implies that uni-directional models (concept ⇒ body) are inadequate and should be replaced by interactionist alternatives (concept ⇔ body). Furthermore, we emphasize that both the source image itself and the body are specifically conceptualized for the context through constructive operations, and both evolve through their interplay. At this level introjection employs representational operations that are embedded in enactive dynamics of a fully situated person.

1. Introduction

The use of verbal imagery instructions is a frequent pathway to instill, enrich or transform bodily experience and skills in somatic practices, alongside other significant ones such as mimetic or interactive instruction (Shilling, 2017; Underman, 2022). The defining characteristic of such verbally mediated somatic imagery is that it is directed towards a bodily target and, therefore, sensorimotor functions, regardless of whether the expression used is literally about the body or whether a figurative expression is used for similar purposes.

This contribution argues that making verbally-mediated imagery productive for the sensorimotor system is a complex form of sense-making whose processual aspects have been largely neglected by scholars. To develop a process model we will draw from various strands of prior research that provide pieces of the puzzle, before examining different process realizations

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in three extended case studies. The principal aim of our model will be to illustrate the tight functional interplay of attentional, imagistic, sensorimotor and linguistic constituents, while highlighting that the nature of our topic requires integrating multiple theoretical perspectives.

By providing a detailed process focus we hope to bring to the fore previously little discussed aspects of somatic imagery practices, which can inform embodied cognition debates as well as help trainers and educators in handling different instruction modalities, difficulties and error sources (although due to space limitations we cannot address pedagogical implications at this time). The final section aims to discuss the implications of our model in the light of current theories such as enactivism, ecological dynamics, and cognitive linguistics.

1.1. The cultivation of somatic imagery

It will help to introduce our topic with some illustrative examples: Dance teachers often teach upright posture and good axis alignment using the imagistic metaphor of a thread from which the head is suspended, while an imaginary line extends downward through the body (Franklin, 1996; Kimmel, 2012). A teacher of Gaga dance may instruct a dancer to imagine "a thick ball moving in your body" in order to focus awareness and activate different regions of the body (Katan-Schmid, 2017). To provide yet another example, Butoh teachers may instruct practitioners to "move like mist" e.g. as to lend an ephemeral quality to dancers' movements (Ravn, 2010).

The reasons for which somatic practitioners use verbalized imagery are various; these include neuromotor learning and re-habituation, emotional and trauma therapy, rehab after injury, mindfulness and meditation, perceptual sensitizing, improved memorization, mental action rehearsal, optimized performance as well as creativity (Eddy, 2009; Mehling et al., 2011; Schneider, in prep.). A full review of the range of aims would require a book-length account. E.g., the aim of subtle perceptual awareness of breath in Vipassana meditation is quite different from motor training in athletes. Despite this striking diversity of uses, the common denominator is that creating and using somatic imagery is a form of expertise in its own right.

In the mid-20th century, a multitude of practices employing somatic imagery emerged. This includes pedagogical systems such as Ideokinesis (Sweigard, 1974; Todd, 1968), Body-Mind Centering (Bainbridge-Cohen, 1993), Awareness Through Movement (Feldenkrais, 1972), the Franklin Method (Franklin, 1996, 2012), Skinner Releasing Technique (Emslie, 2009), Alexander Technique (Alexander, 1923), and recently, Embodied Yoga Postures (Walsh, 2021). In addition, traditional practices like Yoga (Łozińska, 2021) and Qigong (Kerr, 2002), as well as martial arts like Taichi (Hjortborg and Ravn, 2020; Wayne and Fuerst, 2013) deserve being mentioned. By the 21st century somatic imagery has also established itself in performance-oriented contexts such as sports and dance where it is used for learning, optimizing performance, and recovery (Ilundáin-Agurruza, 2017; Toner and Moran, 2015), for creating new artistic material in dance (Bläsing et al., 2010, 2012; Giguere, 2011; Tufnell & Crickmay, 2006), to memorize complex movement phrases, for spatiotemporal adaptation and artistic expression (Fink et al., 2009; May et al., 2011). Beyond that, surgeons as well as musicians (Abrahamson, 2020) are known to use body-related imagery. Finally, in the psychotherapy field imagery directed at a patient's somatic constitution plays an increasingly recognized role in "body-based interventions" (Tay, 2017).

All these somatic imagery practices are mediated in socio-cultural ways. Many of them happen in a community of practice and they may involve interactions with others in group learning, observational learning, or even through direct physical manipulation by a teacher. In many such communities of practice inputs received from teachers, self-experience, and spontaneous private imagery become confluent and add up to complex effects.

1.2. Defining introjection

Our present analysis is concerned with somatic imagery, i.e. imagery that takes the body as its target, and that is conveyed through language.[1] We will refer to an individual person's language-induced sense-making as "introjection". Fisher (2017) explains this as a process whereby a *stimulus* triggers a *mental image*, which in turn *affects embodied practice*. The process starts with a semantic vehicle, often triggered through an instructor's input, which calls up forms of more or less complex imagery, which the "user" will then endeavor to implement with respect to the body. Introjection thus involves a process in which an as yet, non-bodily mental image becomes sufficiently aligned with the perceived and experienced body so it can be made productive for somatic ends. Establishing embodied relevance involves "exploring the ways in which the source entity (encapsulated in the image) is like the body or possible movement" (Fisher, 2017, p. 256).

In this process, body parts and images may be related to each other, such as "imagine your arm is a vine" or "a ball is moving inside your arm." Many examples of introjected imagery directly target a bodily locus, for example in a topological capacity ("you are a tree") or a dynamic/qualitative ("move as if you were mist"). Other examples operate more indirectly through a focus on the surrounding space ("move as if you are in water"). Yet, other examples of imagery are extend outwards, e.g. to interaction partners ("you and your partner circle around a central point").

[1] Although we will deliberately bracket these out at present, similar processes can be mediated through imagery carried by gestures (Kirsh, 2011), pictorial depictions, and even music.

The phenomenon of introjection has a variety of different manifestations. According to the survey in Fisher (2017) the "what" dimension of imagery includes different perspectives, image contexts, and sensory modalities.[2] Imagery can relate to short movement moments, or extended sequences, or specify no temporality at all, be conventional or creative, be detailed or sketchy, local or global, static or dynamic (i.e., involving mental transformations) (cf. Clark and Paivio, 1991).

A second distinction that Fisher proposes is the "why" of somatic imagery usage. This can pertain to cognitive (meaning or memory related), affective, or directly physical functions. Some images can sensitize attention or perception; others may support action preparation, execution or modulation of ongoing actions, rehearsal of action sequences without overt movement, action correction, or technique learning. Furthermore, imagery may be used with or without actual movement.

A third crucial distinction runs between literal imagery instructions and such based on figurative language (following prior dance imagery literature, Fisher (2017) calls this "direct" and "indirect" cues, respectively): *Literal cues* occur in movement instructions for a specific body part ("push your heels against the ground") or the whole body ("imagine jumping"). *Figurative cues* refer to something body-unrelated, e.g., when the body or a body part are re-conceptualized in terms of a vessel moving on water, a ball filled with air, a ray of light, a flat window pane, a marionette, or an octopus. Somatic teachers frequently use metaphors, analogies and similes because they structure unknowns (e.g. invisible inner changes) in terms of something recognizable or provide a catchy integrative image for something complex. Thus, appreciating the many shapes and forms of this phenomenon warns against possible theoretical overgeneralizations.

Given that bodily effects stand at the center, the linguistic practices involved in introjection may be characterized as "soma-languaging". Soma-languaging occupies a special and peculiar position in the broader category of embodiment of language in which the body is infused with new meanings through in situ practice. The body-involving power of soma-languaging is due to its particularly experience-near semantics and the capacity to involve us physically and viscerally. In other words, even simple body expressions have noticeably different effects on us than semantics referring to other things "in the world". For example, the word "arm" not only lets us imagine what limb this may refer to, but has subjective bodily meaning in terms of motor activation, proprioception, body position, balance, pain, temperature, and even a sense of inner organs. Language that refers to the body has a potential "my-ness", since our body is a locus of self, agency, and experience. Whether an introjective process succeeds can therefore be directly evaluated against effects produced in the sensorimotor system. The special criterion of embodied "my-ness", as we will later explain, defines the special position of introjection in the wider research on embodied language.

Finally, note that imagery in bodily practices is a wider category than what we term introjection here. For example, imagery that is used for motivational/self-confidence or strategizing aims (Guillot and Collet, 2008) may focus on visualizing body-external events such as successfully completing a competition or strategies of interaction on a playing field. The way in which such imagery may inform bodily responses is too indirect to count as "introjection" in the narrow sense. For this reason (amongst others) it is important to stress that introjection frequently occurs in a broader context of other body-related imagery practices. Introjection is frequently continuous with more "private" imagery uses, e.g. when a dancer condenses their knowledge of a complex technique in a personal image. Moreover, there is continuity to imagery that is less language-mediated. One such case is spontaneous pretense play (Weichold and Rucińska, 2021) when children frame objects or themselves as something else, e.g., for having a conversation through a "banana telephone" (Gallagher and Lindgren, 2015; Rucińska and Fondelli, 2022 on "enactive metaphor").

2. Multi-disciplinary inquiries into introjection

In this section we introduce different perspectives on introjection and clarify which stakeholder communities are involved. In doing so, we aim to draw attention to the fact that explaining introjection splits into multiple smaller explananda which are important to hold apart.

2.1. Studies of introjection process

Before turning to the "periphery" of the many adjoining debates, we should emphasize that we know of only a handful of cognitive studies that address the *process* of introjection head-on. The embodied cognition researcher McIlwain and the philosopher Sutton (McIlwain and Sutton, 2014) explore introjection in a detailed case study of Yoga, which highlights the reciprocal influences of embodiment and thought. The authors focus on deconstructing unproductive body habits, and discuss phenomenological aspects of how body awareness can be developed. They claim that a body can be mindfully "inhabited" or "colonized" through metaphors. A wider context for this research is Sutton's (2007) work on movement

[2] In terms of *perspective*, imagery can be called up from an internal (egocentric) or external (allocentric) perspective (Madan and Singhal, 2013), or switch between these. In terms of *image content*, the focus can be shapes, surface material qualities, dynamics, relational information such as geometries, and many other aspects. In terms of *sensory modalities*, imagery can implicate kinesthesia, proprio- and interoception, balance, vision, and sometimes other senses as well, and it can often be multi-sensory.

learning via instructional "nudges", something also found in the "continuous improvement" perspective (Toner and Moran, 2014).

Dancer and embodied cognition researcher Fisher (2017) presents an analysis that is informed by, both, cognitive linguistics and Gentner's analogy structure mapping model (see below). It highlights how linguistic work and work on analogy can inform the systematic analysis of how verbal inputs connect with particular aspects of the body. Her study also contains a detailed analysis of the specific counterpart connections that need to be built between imagistic concepts and the body. Similarly, Kimmel (2012) analyzes a number of metaphors used by tango teachers from a cognitive linguistic angle, focusing how different instructions complement each other in complex mental models.

Learning researcher Abrahamson embraces a perspective from ecological dynamics, which emphasizes self-organized adaptations of the organism in response to changed constraints and how the coupling with the ecology guides learning. Abrahamson (2020) explains that language is one such constraint, i.e. "imagery coming from metaphor […] constitutes a constraint projected into the action–perception dynamic landscape" (p. 233). He presents a detailed micro-genetic study of music learning, while making a bid to interconnect the perspectives of phenomenological philosophy, ecological psychology, and enactivism. In an earlier study, Abrahamson et al. (2016, p. 2) argue that movement practitioners "must readapt to the changed environment so as to continue seeking to satisfy their assigned objective […] by developing new goal-oriented motor-action coordinations better suited to the modified circumstances". Similarly, recent enactive-ecological work on metaphor has looked at how action-related affordances emerge from language (Jensen and Greve, 2019) and how metaphor is enacted (Gallagher and Lindgren, 2015).

The first thing to note is that these studies are each selective in their own way, as might be expected with a broad topic such as this. They tend to stress different mechanisms such as body reflexiveness, responsiveness to ecological affordances, or imagery-based language processing. What these studies have in common is that they accord the body an active role and acknowledge reciprocal causalities of body and mind. This is not always apparent in the chosen terminology however. For example, introjection has often been expressed as conceptual mappings *from* images *to* the body (Fisher, 2017; Kimmel, 2012). We will presently avoid this parlance, because – although this is not actually always true of mapping processes – the term can be construed as suggesting a unidirectional projection, an idea which runs counter to the evidence we will present below. Similarly, McIlwain and Sutton (2014) title their study "how words alight on bodies", which might be construed as a unidirectional model.[3] In their analysis, however, the body's contribution becomes quite evident and the authors stress that "thinking and acting can … work together", thus highlighting "the reciprocal influences of embodiment and thought" (p.2). Abrahamson's (2020) ecological dynamics perspective of metaphors as constraints on perception and action circumvents the implication that words can be simply "grafted" to bodies in a more principled way. This parlance makes room for a self-organizing context-sensitive process, which neither presents images as an isolated first cause, nor the body as a static recipient.

2.2. Somatic imagery research

Whereas the cognitive process literature may be slim, there is a broad and long-standing fascination with somatic imagery more generally, which is reflected in a range of different methodologies. We will now survey these "adjoining" research fields that inform our discussion of introjection.

Dance-focused qualitative studies showcase the variety of deliberate imagery (Hanrahan et al., 1995; Hanrahan and Salmela, 1990). For example, Nordin and Cumming (2005) differentiate between *execution images, metaphorical images, context images, body-related images,* and *character/role images*. Hanrahan and Vergeer (2000) distinguish (a) *inspiration, atmospheric*, *metaphysical imagery*, (b) *filling/emptying imagery*, as well as (c) *specific movement and projection imagery*. Among these, the first subset deals with the background of dance production, the second pertains to mental preparation for dance, and the third focuses on motion itself and its intended effects. The meta-study by Munroe et al. (2000) coins the "4 Ws" of imagery use, the "Where, When, Why, and What". A meta-study by Pavlik and Nordin-Bates (2016) discusses categories of the "Dance Imagery Questionnaire", which includes four types: *technique imagery* (for the mental rehearsal and perfection of movements), *mastery imagery* (for controlling anxiety or staying focused), *goal imagery* (end-points of desired achievements), and *role and movement quality imagery*. Questionnaire methods have been devised in which people are asked to assess their own motor imagery ability, including the *Vividness of Movement Imagery Questionnaire* (VMIQ; Isaac et al., 1986), as well as more "objective" tests such as the *Test of Ability in Movement Imagery* (TAMI) in which participants are told to imagine a series of bodily moves and then decide which visual image from a set best corresponds to their final position (Madan and Singhal, 2013, 2014). The latter approach correlates individual movement imagery ability with performance differentials (skill levels, performances types, etc.).

[3] The metaphor pictures the body as a relatively static recipient, i.e. a ship moves while the pier stays in its place.

Experimental approaches on imagery are equally frequent (Ely et al., 2020; cf. also Cumming and Williams, 2012; Cumming and Ramsey, 2009), often conducted in the interest of developing recommendations for coaches. It has been shown that training with motor imagery reduces the need for execution, whilst still leading to improved performance (Simonsmeier and Buecker, 2017). A meta-study concludes that imagery enhances motor performance in athletic disciplines such as gymnasts, archery, basketball, cricket, darts, field hockey, figure skating, fitness, golf or soccer, and adds to the effects of physical practice (Simonsmeier et al., 2021). Mental or combined mental-and-physical practice have been shown to be superior to solely physical learning. Imagery has also been shown to have positive effects when physical training is not available, benefitting muscle strength (Iacono et al., 2021), flexibility and stretching (Guillot et al., 2010). There is evidence that using imagery together with small movements is highly effective in training and rehabilitation (Guillot et al., 2021). Note that, while most of these studies investigate literal movement instructions, some compare the effects of metaphorical and literal cues (cf. Heiland and Rovetti (2013) and Böger (2012), who incorporates cognitive linguistic ideas).

Neuroscience literature adds to this by illuminating the background mechanisms for such effects. The basic question is addressed of why imagined inputs are capable of producing effects in the sensorimotor realm. Jeannerod's (1994, 2004) work on motor simulation famously showed that imagined and actual movement overlap in their neural substrates.[4] Neuroscientists have investigated movement preparation and rehearsal effects through brain activation measures (fMRI, EEG, etc.) or through electromyography, which records muscle activation and offers a way to capture covert activation (Jeannerod, 1994). It has been subsequently shown that imagery practice results in neuro-physiological reorganization similar to learning effects through movement execution (e.g. Pascual-Leone et al., 1995), although a review by Frank and Schack (2017) points out some neglected nuances. They argue that the action representations generated by imagery or mixed practice are more elaborate than from execution practice alone, but not functionally equivalent in the strict sense, as they target higher levels within the motor action system. Filgueiras et al. (2018), in a meta-study of 29 experiments, find that neural structures involved during visual or kinesthetic imagery include activation of the somatosensory cortex, premotor cortex and supplementary motor areas.[5] Following the neuro-science tradition, it has been proposed that mental training is functionally and/or "neurally" equivalent in many respects to physical training (Sharma and Baron, 2013), but caution has been advised not to overestimate the extent of equivalence (Ietswaart et al., 2015). For example, imagining participating in a boxing match does not typically result in physical fatigue or soreness.

2.3. Linguistic research

We know of only a handful of linguistic studies that address introjection contexts directly, i.e. Kimmel (2012), Kapsali (2014), Fisher (2017) and Łozińska (2021), while Jensen and Greve (2019) address the phenomenon indirectly. However, general work on language processing offers a vital theoretical background for our topic on two counts. First, general psycholinguistic language comprehension research explains why words can trigger or enrich embodied experience in a convincing way (which dovetails with the reported findings from neuroscience). Specifically, simulation theories of language have experimentally demonstrated that expressions activate similar processes or overlap with cognitive processes that get activated when perceiving or enacting the words' referents. Zwaan (2004), e.g., states that:

> language is a set of cues to the comprehender to construct an experiential (perception plus action) simulation of the described situation. In this conceptualization, the comprehender is an immersed experiencer of the described situation, and comprehension is the vicarious experience of the described situation.

This ability for sensorimotor simulation is a basic condition for words to resonate in bodily experience. Cognitive linguists second this claim, while also alerting us to how language provides "assembly instructions" for imagery (Evans and Green, 2006). According to the cognitive linguistic view, language does not simply "depict" things; its users must engage in active *meaning construction* (Evans et al., 2006) that contextually highlights or interconnects particular aspects. Language use therefore involves constructive imaginative acts. This claim explains why linguistic sense-making frequently provides several different ways of relating to the same words and sensitively responds to context.

As their second principal contribution to our topic, cognitive linguists offer a *general* model for explaining how verbally cued imagery and the body connect. Research on metaphor in the Lakoff/Johnson tradition has led to insights about how different conceptual domains may be interconnected for the purposes of thinking (e.g., Lakoff, 1993). This work has also proposed a cognitive model of metaphor creation and comprehension. A key claim is that an *isomorphism* of a conceptual source space with a target space must be created. If we apply this line of thinking to introjection, a bodily target space is at

[4] The responsible muscles for an imagined movement are tentatively innervated in patterns matching the characteristics of the actual movement (Guillot et al., 2012); moreover, activations have to be inhibited not to lead to overt movement (Jeannerod and Decety, 1995). So the act of imagining doing things with the body can be seen as (partially) inhibited actual movement. This is known as the "functional equivalence hypothesis" (Moran et al., 2012; O'Shea and Moran, 2017) which postulates an overlap of neural and representational substrate of acting, intending, action observation, and imagery. Thus, for example, movement observation activates similar neural areas through the so-called "Action Observation Network", although this depends, in part, on familiarity with the movement (Calvo-Merino et al., 2006).

[5] The latter two areas are responsible for transforming the volition to perform a complex movement into a sequence of steps. The review also isolates some specificities of visual imagery of movement appearance vs. kinesthetic imagery of movement "feel", although it is unclear if perspectivization explains the results. The authors caution against any neurobiological dichotomy, since the two modes may typically co-occur.

issue, i.e. a person's embodied here-and-now with its various situated characteristics, which needs to be set into correspondence with a source image created from a linguistic expression.

Creating sufficient correspondence seems a relatively straightforward task for literal cues such as "drop your shoulders" which trigger multi-modal images of a movement, which can then trigger sensorimotor activity. In contrast, in the case of figurative cues we face a massive explanatory challenge. Metaphors, similes or analogies (and to a lesser extent general geometrical expressions) employ "non-body-formatted" expressions, implying that an isomorphism with the body must first be actively created (Gentner, 1983; Lakoff, 1993). The reason is that figurative expressions are, by definition, "non-body-formatted", as their primary meaning stems from an unrelated domain and gets used in a "derived" fashion here, which is actually how we decide whether or not some expression counts as figurative (Pragglejaz Group, 2007). So how an unrelated source image can be taken to pertain to "my bodily here and now" is inherently puzzling. To explain this, cognitive linguists would point to shared invariants between body imagery and imagery "of the world", based on the fact that all sorts of imagery obey similar gestalt laws: Although bodies have many richer characteristics, they can be perceived or conceptualized as being *image-schematically* structured as containers, parts, links, vectors, balance, etc. (Johnson, 1987), just as other perceptual or conceptual entities. These shared gestalt invariants provide a basis for figurative cues to be related to the body. Thus, making sense of "you are a tree", an example we discuss below, benefits from the fact that trees and bodies share invariants such as verticality, similar trunk/torso shape, a basic partonomy, as well as a range of other possible equivalences.

2.4. Phenomenological research

Finally, an influential context for our topic is the growing debate on the "mindedness" of skill (Christensen et al., 2016; Fridland, 2017; Høffding and Satne, 2021; Sutton et al., 2011). Attending to the body, its sensations and movements, is frequently used for the purposes of monitoring action execution, error correction, and deliberate technical refinement (MacIntyre et al., 2014; Montero, 2016; Toner et al., 2016a; Toner and Moran, 2014). Phenomenologists (Legrand, 2007; Ravn and Christensen, 2014; Ravn and Høffding, 2017; Standal and Engelsrud, 2013) discuss this phenomenon as *body reflectiveness*, which turns the agent's attention and intentionality towards the body in focused ways (Hjortborg and Ravn, 2020). Reflectiveness can be seen as a spectrum on which the body can be an object of experience, but can also lie at the periphery of attention or form its background (Colombetti, 2014). This means that a *felt sense* of the body (Legrand and Ravn, 2009) can often be "subtly reflective" and the body can "be apparent without being an intentional object of awareness" (Toner et al., 2016b, p. 311). Even if body sensations frequently become "self-forgetful" (Leder, 1990) through habitual skilled practice, they seldom fully recede from awareness. These phenomenological categories are useful to describe how skilled somatic practitioners, who quite typically move between different modalities, orchestrate the relation to their body e.g., when switching between "thinking of movement" and "thinking in movement" (Sheets-Johnstone, 2009) or bring reflective and more pre-reflective modes into interplay (Ravn and Høffding, 2017). In the process of skill learning embodied habits provide potentialities for practice, yet may also need to be deconstructed, adapted, or overcome to improve (Purser, 2018), which is something that happens through focused reflective attention to habitual body behavior.

2.5. Interim evaluation

Qualitative studies have performed an important task in alerting us to the many shapes and forms of imagery, and the fact that introjection is part of a wider field of imagery practices. The fact that the phenomenon has so many different facets and variables indicates a need to be careful with generalizations.

Neuroscience provides a general basis for explaining why mental imagery, once it has been cued, can produce sensorimotor activations. Neuroscience and experimental studies on imagery have also tested usage effects which confirm what practitioners have long known, while also filling in less known details. At the same time, much of this research is beholden to a stimulus-outcome framework and processes are dominantly treated as a black box. Very little is currently known about the wide range of variables that need to be subject to experimentation in the future.

Psycholinguists and cognitive linguists emphasize the all-important basic connection between language and embodiment and have given us a basic working model of how language interconnects different domains of experience – first steps to understand how introjection cues resonate in the body (but with limitations that we will discuss in Section 5). Linguistic work on metaphor and other figurative expressions also provides a toehold for asking how body-unrelated images can be predicated on the body in introjection contexts. Finally, linguists demonstrate that the dynamic nature of imagery (i.e. the assembly, perspectivizing, and "running" of mental scenes) offers resources for sense-making, a claim we will try to apply to the body later in this paper.

Phenomenology has brought the first-person perspective to our attention, which indicates that humans have multiple ways of reflectively relating to their body and that they routinely use these to make sense of their actions and interactions in context. Despite the many useful conceptual delineations, the discourse on body reflectiveness largely leaves in the dark how

verbal cues by others (i.e., external input) can enrich or challenge one's existing bodily states, rather than simply making them conspicuous, and fails to address the non-trivial role of language comprehension.

Overall, no current account seems inclusive enough. It is therefore important to realize that introjection involves multiple explananda, some of which have been explored more than others. What we know quite a bit about is how words give rise to mental imagery, why mental imagery can activate sensorimotor states, and what enables metaphors to be understood in general. What we know less about is the process whereby imagery-rich language is contextually constructed and made relevant to the body in its present situation, its background of habits and preferences, and what makes the body a special kind of "target" for language. Inevitably, we cannot provide a full answer to all of these questions, but our aim is to provide a plausible working model and make us alert to different aspects of the process.

3. A process model of introjection

We will approach introjection as a sophisticated and multi-stranded form of sense-making, in which a practitioner, possibly with the guidance of a teacher, co-orchestrates body awareness, linguistic abilities, attention, and sensorimotor mechanisms in the interest of a performance or learning task. Our aim is to sketch a working model of this process and identify some of its central characteristics. Specifically, we propose that introjecting is a dynamic and often recursive process which requires creating sufficient *alignment* between (a) mental images cued by words and (b) sensorimotor potentialities of one's body or some body-related target.

3.1. "Being a tree" – an introductory example

As a first illustration, let us take a metaphor: "you are a tree". To make sense of this the first step is to conceptualize the source-domain expression "tree". A seven-year-old might conceptualize the tree's shape, size, and structure. An adult might alternatively access aspects of acquired knowledge from biology or ecology, for example, how trees exchange energy with the ecology. There are many possible tree memories or prototypes to call up, as well as many possible tree features to make salient. This initial process will typically happen in a contextually motivated way, depending on how the practice context in general is understood, but also depending on prior skills, personal preferences and other factors. Making sense of training aims is particularly important to this.

Another required step is to make this tree conceptualization relevant to the body. An imagined tree is a body-unrelated entity, so it needs to be made sense of in relation to the body. For this, potential counterparts with body features need to be identified. Possible correspondences include matching the trunk to the torso, the bark to the skin, the roots to the feet, the sap to blood (or to an abstract notion of energy flow), the use of water to drinking, plant growth to body growth, and so on. Note that many possible features of what is known about trees might be discarded as not fitting, e.g. immobility, having leaves, or seasonal shedding of leaves. Thus, the source image requires selecting a meaningful conceptualization among many possible ones. Depending on the context, the user will also have to decide if the source image is best made sense of in relation to body topology, body dynamics, body feeling, or other body features. In this process, attributes and relations between the tree image and the body come to be meaningfully aligned (Gentner, 1983, 1988), which we can think of as interconnecting two "spaces", a source image with some target aspect pertaining to the body. The alignment process must take into account the current body position and dynamics, as well as general topological invariants of a human body (relations between parts, etc.).

As the process begins, the user may engage in active operations that provide a better fit for the tree image. In one type of operation the body follows the image, i.e. the body is adapted to the solicitations of mental imagery. For example, if sitting in a position with bent legs, projecting the image of a straight, vertical tree is difficult and even if your legs stretched out this might not fit the image specification of a tree enough. One good option could be to stand up to be more tree-like, stick one's arms outwards to "be" the tree's crown, or make the elbows angular so the lower arms point upwards like branches. In the opposite type of scenario, the user adapts the image in the mind and might, for example, begin imagining a crooked tree which resembles the position of the bent legs.

In this process, aspects of mental image interpretation and body exploration begin to interact. On the one hand, highlighting the bark of the tree in the mental image may direct attention to skin sensations. On the other hand, the source image may itself be enriched or re-interpreted in response to specific body feedback. E.g., when the person becomes aware of a subtle postural sway this can direct the focus to the tree's elasticity and subsequent explorations of how to make sense of this. In many contexts, the process of interpreting the image engages an increasing number of sensorimotor aspects as the incipient alignment starts to "play out". The person might imagine the body center to be a powerful trunk and in doing so become upright and stick the chest out or connect the abdominals and lower back muscles. She might imagine that the lower

body represents the roots of the tree and (as one possibility) make the feet "root-like", so the whole foot and the toes spread out as widely as possible or stand with legs open so the whole legs become the spreading roots. She might imagine the roots growing into the ground and in doing so try to be as well-grounded as she can or push the soles and toes into the ground. She might also engage in more subtle operations, such as imagining a flow of sap through her body, which opens the blood vessels, or shifting attention to the "branches", etc. Making sense of the body in terms of selected tree features can, variously, motivate movements, shifts in body attention, highlight subtle sensory facets, micro-calibrate muscle tone, or activate autonomic processes. The tree image may simply create a stronger innervation of leg muscles or a more organic spine position. In due course, working with this image can also trigger more general insights, such as grasping general principles of a relaxed, strong stance. This wealth of contextually possible options emerges from the rich possibilities of matching the parts, shapes, or functions of a tree to the parts, shapes, or functions of the body as well as the many possible ways of activating the body.

3.2. Convergent, multi-polar alignment

Our proposed theoretical framework does not assume that words "simply mean" specific things for the body. Rather, it defines the introjection process as a complex form of sense-making in which multiple "intentional objects", i.e. the verbal cue, the present body, and the task context, are set into a relational perspective. This sense-making is akin to a dialogue in which processes at an image pole and a body pole must be meaningfully co-orchestrated until they sufficiently align (Fig. 1). Sufficient alignment can be convergently worked on, and improved from both ends by co-adapting the image and the body. Thus, process features more directly associated with the body and those more associated with "mental" language processing need to be orchestrated in mutually meaningful ways so that they continuously inform each other. The process can be seen as one of exploration that is constrained by both the words and the person's physicality and situation.

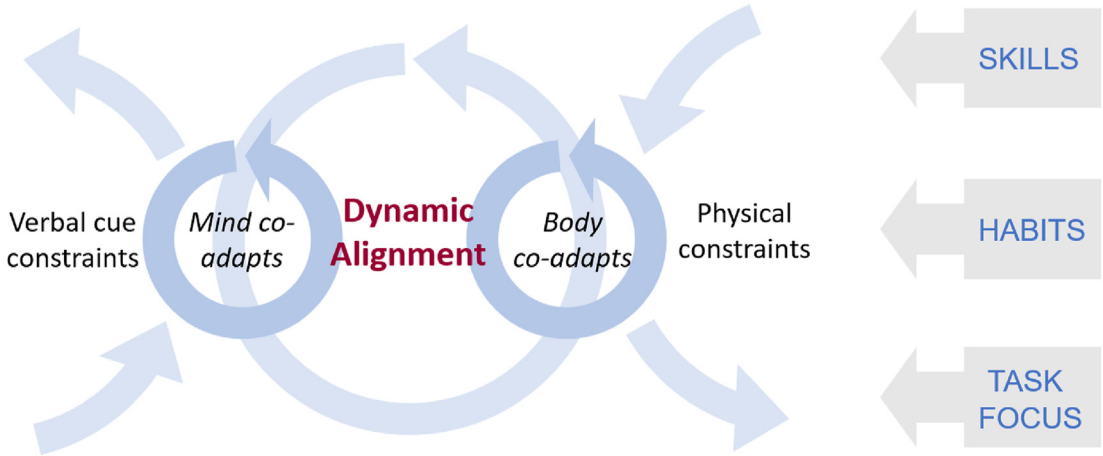

Fig. 1. Sense-making through co-adaptive alignment of an image and a body pole; right = variables that modulate the process.

A central assumption of our model is that the alignment process is genuinely bi-directional. Ongoing body experience can change how a mental image is understood and working with the image, inversely, can change processes of experimenting with or attending to the body. In the process of interplay, the felt body can suggest re-framing or adapting the image just as much as the image can guide the body's activities, attention or subtle responses.

In all this, the body is an eminently active agent and far from an inert "receptacle" for imagery, and actively contributes to the sense-making process. It literally provides a "moving target" for imagery. How mental imagery is conjured up in the details will often be responsive to the body's initial state and orientation, as well as being constrained by prior skills, habits, and the task ecology, as depicted in Fig. 1. On the other hand, attention to the body will often be pre-coordinated before the alignment process is complete because the broader constraints of the source image are immediately evident.

Another key assumption of our model is that the alignment process can run through iterations which progressively improve the match between image and body. Often, how an image is construed in the mind can be gradually refined or expanded over time, as the body adapts its movements, active sensing, and attentional focus. As our case studies below will

show, a person may recursively interpolate between expanding attention to new body parts, exploring feedback, postural adjustments, and identifying new candidate features in the image. This recursive process can be propelled forward by registered effects of self-explorations or small adjustments, task feedback that provides new "clues", re-checking if the image does what instructors intend, as well as embodied insights that trigger next level processes.

To sum up our framework, introjection depends on coordinated multi-polar sense-making in which a mental pole and a sensorimotor pole become aligned and synergize. Both the body and the image can be explored and enriched in an interleaved fashion. Consequently, we reject a view of a mere top-down process whereby language simply "infuses" the body. Even in cases in which the body ostensibly is doing little at the surface, introjection is no uni-directional projection on an inert somatic substrate; when we look closer it invariably requires a recursive bi-directional interplay between source and target structures that are both open to exploration.

3.3. Key features of the introjection process

We think of introjection as possessing the following general characteristics:

- **Multi-intentionality & integration:** The process interconnects different cognitive components in highly dynamic (and frequently consciously supervised) ways, as it requires co-orchestrating mental and somatic adaptation skills.
- **Temporality:** Individual introjection processes have a distinct phenomenological unfolding. When an image "clicks" immediately this happens in micro-time, whereas processes that run through recursive explorations, revisions, or refinements are visible in macro-time as well.
- **Transformation:** Introjection is a system-changing event, a somatic (micro-)learning and discovery process. Introjection rather characteristically presents "difficult" images that challenge habits or elevate hidden body structures to the foreground; new images may require interconnection with familiar ones. Even in cases in which familiar imagery is just re-instated, it is a process that actively engages or even expands or reshapes skills.
- **Embodied problem solving:** Often the process can be thought of as step-wise problem-solving, depending on how the task itself is understood. Especially in learning contexts imagery can trigger a trail of active "figuring out".
- **Background enrichment:** Introjection draws on an implicit background of prior skills, habits, and exploratory preferences. Recognizing these is important for understanding individual trajectories of introjection, both successful and less successful ones.
- **Normativity/contingent success:** Even creative imagery use is not an "anything goes", but answers to constraints. Any alignment process can fail, partly succeed, clash with the instructor's meaning, seem mismatching with one's skill or preferences, or feel shallow. Since a good match will frequently depend on constructive "manipulations" at both ends, both how the source image and the body are handled can prevent or license a good match.

Therefore, introjection is best seen as a durationally extended process of enrichment and discovery that is inherently precarious because it answers to domain-, context-, and person-specific success criteria. We shall now take a closer look at different contexts, including open, creative explorations and very strict and normative technical contexts, in which there are "incorrect" ways to interpret the image. The examples thus illustrate different "power distributions" between an image and bodily exploration, from narrowly defined training aims to tasks in which an image can be flexibly handled.

4. Three process vignettes

The aim of this section will be to refine and validate our model by unpacking some real-life cases, which will enable us to compare different process trajectories. Our methodology is auto-ethnographically informed, and reports on practice experiences of authors 2 (SMS) and 3 (VJF), who have explicated these experiences in a structured dialogue with the other two authors. All three authors can lay claim to considerable proficiency in somatic practices, structured reflection of embodied experience, and skill in eliciting this in others. The first author (MK) specializes in micro-phenomenological methods of skill analysis (Kimmel, 2012; Kimmel and Hristova, 2021; Kimmel and Rogler, 2019), informed by Explication Interviewing methodology (Petitmengin, 2006). The vignettes will follow each introjection experience into its details, written in ways that may even encourage vicarious or "mimetic" re-living. Each vignette begins with a summary overview and illustration for easier reading and general orientation.

4.1. Vignette 1: Dance

Practice context: A self-led dance context, using an image that is predominantly visual and kinesthetic (the same image was revisited following many previous encounters).
Aims & meta-pragmatics: Free improvisation to explore movement possibilities
Input/source: Figurative imagery: "my pelvis moves like a shoal of fish"

Timescale: 15 minutes
Analytic summary: The vignette highlights

- An initial warm-up process of re-actualizing counterparts between image and body
- Creative elaborations which orchestrate the relationship between the body and the source image dynamically, including exploring a conceptual blend

Fig. 2. "Pelvis as a shoal of fish" in dance improvisation.

In our first vignette, we shall look at the introjection of a metaphor in a dance context, as experienced by the third author (VJF), who has 40 years of experience in dance improvisation. Among the many ways that improvisatory practices use imagery, we report on a predominantly visual and kinesthetic image in an exploratory exercise driven by the question of "what movement is possible if I allow it to be guided by immersion in the image?" The goal is not technical mastery, nor is there any predetermined movement pattern to be attained.

The input image was "my pelvis moves like a shoal of fish", a metaphor with the general goal of exploring movement of the pelvis in terms of both physical range and quality of movement. VJF (re-)visited the creative and improvisational possibilities contained in this metaphor, based on extended prior engagement with it as a student, dancer, teacher and researcher. We also selected this vignette to illustrate how basic imagery skills can be further elaborated once a practice "substrate" has been established, so that previously rehearsed practices, within a long usage history, set the stage for "next level" scenarios. Since the shoal of fish image is a somewhat openly specified image, much depends on the user's

willingness to enter into a playful and exploratory "as if" relationship with it. This improvisational character reflects a particular *meta-pragmatic* stance (Sawyer, 2003) towards the task, which avoids limiting the creative potential through over-analysis or self-censorship.

The dancer's exploration of how the shoal of fish image could be rendered somatically productive can be divided into two main phases, an initial re-visiting of the basic image and situating it in the body, and "next level" creative explorations that emerged as the process went on.

In the first of these phases VJF began to familiarize herself with previous memories of the exercise which helped her re-actualize familiar connections between image and body. This involved several more specific processes: VJF first *identified the target region* of the body in which to situate the image projection, in this case the pelvic region. This decision provided a focus for what body parts to explore whilst other regions were allowed to recede into the background of attention. By zooming in on the pelvis with her attention, she then *identified further possible anatomical anchors* to establish an approximate topological orientation in her felt anatomy. VJF reports that the shape of the shoal she imagined corresponded to the shape of the pelvis supporting the organs of the lower torso, both having an approximate, elongated ball-like shape. (However, she did not go so far as to map individual fish to particular locations in the pelvis; rather the shoal remained loosely tethered to the body.) In establishing these approximate correspondences, she allowed her felt awareness of inner body features to become a set of "targets" for the various features of the shoal image. The posterior of the shoal hovered, anatomically speaking, around the sacrum, the side-most fish floated near the greater trochanters of the femurs, the front and top "massaged" the belly. Using these anatomical anchors allowed VJF to then focus attention on particular inner body locations in order to explore different movements and their effects.

During this first phase VJF also *established a shared coordinate system* between the cardinal directions in the image and the body in its upright state, so that for example, the circular motion of the fish corresponded to the circular motion of the pelvis. At the same time, she remarked that maintaining a consistent orientation was an improvisational choice among others (along with the choice to perspectivize this "from the inside out" instead of assuming a 3rd person viewpoint).

VJF then experimented with different movements *to establish dynamic matches* between action possibilities of the pelvis and how fish in her image could swim. Her options included trying to match movement qualities, rhythms, and/or directions performed by the imaginary fish. She settled on focusing on imagining the shoal's motion as instigated by individual fish, with the rest following along whilst maintaining a fairly regular spatial relationship and proximity to each other, as though loosely bound. She imagined the gaps between them as expanding and contracting in a liquid fashion and used this to explore similarly liquid qualities of pelvis movements. Whilst she imagined sudden, sharp changes of direction, the shoal remained a connected whole through which pathways of movement pass, a way of construing the image which informed an overall smoothness of pelvis motion. And since experimentation was the acknowledged purpose, she matched the various fish movements to shifting points of kinesthetic attention which pulled the pelvis in diverse directions in 3-D space and with varying dynamics.[6]

In addition, VJF reports *elaborating and evolving the source image* of the shoal, in ways that were triggered by various prior visual, kinesthetic, and proprioceptive experiences such as floating in water. This became a process that continuously evolved as the exercise continued. In terms of source features that VJF made salient she elected to place primary attention on *relations between* constituent parts (i.e. the fish in relation to each other) rather than focusing on the parts in isolation. She found this the most productive way of construing the source image, since it allowed for exploring different dynamics and "leading points" found in the circular space of the shoal, in the analog space of her pelvis. In contrast, allocating increased attention to the individual fish was an option she rejected as problematic, since these have no direct analog in the pelvis.

As part of this evolving dance process, but still based on the fundamental decisions about aligning image and body features, "next-level" creative practices ensued. These all involved complex constructive processes that at first unfolded in the world of the image, but soon began to interact with the dancer's actual body.

As this process started VJF reported entertaining a primarily visual image of a small shoal of glittering fish that floated in the space that was occupied by her pelvis. She projected the image directly into herself, conjuring up a blended image of "her body with fish in it". This happened as she attended to her body with closed eyes and focused on sensations of breath and tension, contact with the ground, weight distribution, but also to input from the natural environment, especially the sounds and physical sensations of sun and wind on her skin while dancing. This implies that she created a merger between the image, and actual proprioceptive and kinesthetic percepts of herself.

[6] It is worth noting that her implicit task understanding ("what is it about the perceived motion of the fish that can liberate movement?") guided her decision to apply this relatively holistic focus. The source image was intended to allow a broad range of interpretations, responding to creative whim and changing from one moment to the next (which rather sharply contrasts with other kinds of contexts such as vignette 3 below).

She then became aware of the way the sun's light and warmth began to interact with the fish in the blended image: The light struck from the front-left-diagonal, leaving the back-right of the pelvis in shadow, which she immediately translated into her image of some fish in the corresponding space being in shadow. This in turn drew her attention to the fact that her back-right pelvis area felt less relaxed and flexible than the rest (i.e. darkness matched with felt immobility). In this process she came to blend an experiential feature of her body with the image, allowed her to explore how qualities inherent in the image could be used to relieve the tension. She said she tried to spread the sense of light and warmth into this colder, stiffer region, moving attention away from the actual environmental input into an imagined scene in which there was more light and warmth altogether. This was an effect that VJF orchestrated "through the image", as it were, and it succeeded in producing a corresponding effect in the body.[7]

In a second moment, VJF actively elected to prioritize attention to a new possible feature of the source image, namely the fluid, soothing motion of water in which the fish were suspended. This feature felt as though it liberated the pelvis and generated easy, gentle motion. She noticed that while her primary attention was on tracking the imagined motion of the fish, her body moved empathetically with it, but without deliberation. She commented that "sometimes it feels as though the movement is just happening […] that it is the fish that are moving", and the body simply follows.

A third moment of evolving the image involved a two-step creative development of the metaphor, reflecting what cognitive linguists describe as metaphor extension or elaboration (Lakoff and Turner, 1989; Turner, 1994). This occurred as VJF experimented with giving the imagined fish greater agency in order to expand her range of motion. She noticed that an unrestrained shoal of fish could easily result in them shooting up vertically, but that a land-based human pelvis cannot do so analogously and is more constrained. In response to this she began to back-project the actual constraints of her body to the world of the image, rather than try to enact physically impossible things. This is a key example of the bidirectional nature of how body and image interact, with potential mismatches on the body end resulting in limits to how creatively the image was developed in the mind. In the process of this back-projection, VJF first imagined the fish as moving in a constrained way that would easily align with the anatomical and physical limitations of her body. This made her keep her feet rooted to the ground. Later she expanded the image more consciously to reflect the back-projection. She now imagined a net containing the shoal so the fish that want to move more, cannot (as opposed to fish that chose to stay in a confined space). The practical effect of this image extension was that her movements acquired qualities of struggling against resistance. Still later, VJF wanted to see what effect it would have to free up the motion of the fish by imagining them breaking through the net. This led the previously tethered pelvis to move beyond the base of the feet, ostensibly pulling her off balance.

To recap, all three of these "next level" moments illustrate how somatic practitioners can actively elaborate and creatively orchestrate the relationship between the body and the source image. The vignette as a whole highlights how particular introjection inputs are used to explore creative movement possibilities and widen one's experience. It also illustrates that perception can seamlessly merge into imagery (e.g. when the actual light "shone" on the shoal of fish), that "as if" imagery states can be created to invite analogous effects in the body, and that constraints of the image's "world" can be creatively orchestrated and are subject to on-going modifications whose effects on the experiencing body are explored.

4.2. Vignette 2: Feldenkrais

Practice context: Feldenkrais (named after its founder Moshé Feldenkrais) is a somatic education system, here with a focus on the instructional practice known as "Awareness Through Movement" (ATM), a sensorimotor self-exploration process that is guided by a teacher.
Aims & meta-pragmatics: Exploration of individual movement possibilities to extend the range and ease of motion, following a verbally guided practice sequence.
Input/source: Literal and figurative instructions are combined: The direct instruction to raise one foot to the head in a well-rounded movement; combined with the figurative instruction to "be as flexible as a skeleton without muscles or tendons".
Timescale: 90 minutes
Analytic summary: The vignette highlights

- Exploring movement elements and connecting them into an integral movement
- Exploring effects of a reduced "as if" imagery that strips away flesh, leaves only bones
- Using the metaphor as a search and optimization heuristic in the experiential body

[7] Given that a feature of the source image was mentally manipulated and reshaped in a desired direction, this could be described as inferences that emerge in a "conceptual blend" (Fauconnier and Turner, 2002). An effect that arose from integrating a metaphorical input and the experiential body was then projected back to how the body itself was understood, a mechanism this theory describes.

- Dialectic processes of to-and-fro between experiencing the body and the imagined "model body", hereby refining movement itself while refining imagery

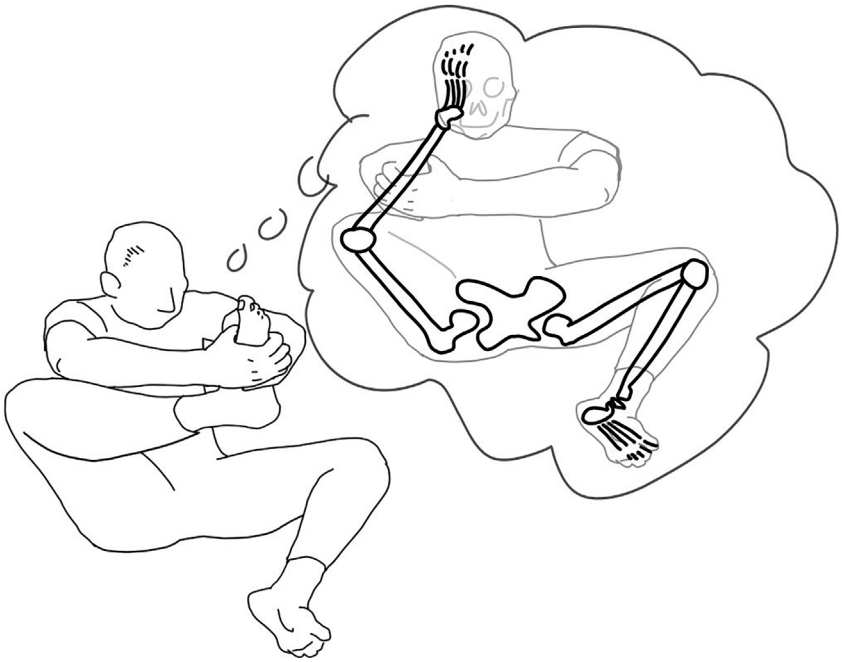

Fig. 3. Enacting movement instructions while imagining oneself as skeleton.

The vignette is based on the Feldenkrais self-experience of the second author, SMS. It involves a multi-stage sequence of literal and figurative imagery instructions used in combination with practical movement exercises. One of the facets the vignette will highlight is how "as if" images of one's body can inform movement explorations.

The "target movement" of the exercise was to raise one foot to the head in a well-rounded movement and without excessive strain, following a recorded lesson by Moshé Feldenkrais. In the 90-minute lesson SMS explored different ways of relaxing tensions, increasing ranges of motion, and creating an easy movement which brings the foot as close as possible to the head.

The first instruction was to sit on the floor and to hold the right foot with both hands. From there, several movement variations were introduced, including one change of position. Each movement was done repeatedly (15–20 times), interleaved with short pauses for a "reset". In the process, sub-movements were attended to one by one and then interconnected. For example, a sequence of moving the leg into a forward, upward, back and lower direction was subsequently extended into a larger circling movement. As this happened, SMS identified possible "players" (i.e. motor system synergists) and muscle activation patterns involved in this. He also tried to spot arising tensions, for example in the soft tissue around his hip, and explored improvements by finding aspects to gently optimize. This happened by trial and error. In addition, other aspects of the body moved into awareness and how they influenced leg movements was monitored. The process of noticing how tiny leg movements resonate elsewhere then allowed SMS to reconfigure several "non-leg" features for a more comfortable raising action. For example, he tried to use available degrees of freedom in the ribcage and tried to release the shoulder blades whilst bringing the chest forward.

Next, a *facilitative image* was provided by the Feldenkrais teacher: SMS was encouraged to think of himself as "being as flexible as a skeleton" – the implication being that a skeleton can move unencumbered by the limits of muscles or tendons. This triggered a new set of problem-solving strategies. SMS immediately recalled a mental image of a skeleton model as usually seen standing in Feldenkrais practices. He easily established counterpart connections of the salient parts of his body (i.e., right hip, right leg, torso and head) to the parts of the imagined skeleton. The next step was to strip away in the imagination the perceived limitations and constraints that tendons, fascia, and muscles produce in the real body. After all, a skeleton is a "stripped down" version of the living body that is topologically similar, but structurally-functionally simpler and devoid of many movement restrictions. So, he created in his imagination an "as if" version of his current state of sitting on the floor, which suggested shedding the felt tensions of the real body that would restrict his movement. In a sense he created a "blended" image in which his body was fully sensate, yet simultaneously reduced and skeletal. SMS constantly interpolated between the restrictions of the real body and the freedom of what it was imagined as. The skeleton model was in this way capable of providing facilitation in overcoming the restrictions experienced in the foot-to-head exercise.

Specifically, the skeleton seemed to suggest a *search and optimization heuristic* in the real body. SMS tried to scan himself and spot tensions incompatible with the imagined skeleton as problem zones to work on (the "where" aspect); then he explored specific ways to release these zones (the "how" aspect). SMS reports that this noticing process started with a failure of his first attempt to raise the leg and noticing that a blockage in the right hip socket was the reason. His next strategy was to shift his attention to work out the problem in the analogous location of the skeletal model. This required a coordinated directing of his attentional focus on a specific part in both the real and the skeletal bodies and exploring the details there. The operation of attentional zoom-in on the hip socket was therefore projected from the actual body to the skeletal model. SMS "ran" the skeletal model in the mind – and came to realize that the skeleton model can easily raise the leg in the front so that the foot comes up and close to the skull. This insight was then back-projected to the body. Now he explored sensory feedback in various small movements bringing him closer to this, and in the process developed awareness of how much looseness the joints can have when bones are considered on their own terms. By dynamically imagining how the skeleton lifts its leg SMS was able to discover that his hip socket offered more wiggle room than expected. Working with the skeleton image encouraged trying the leg lift repeatedly and focusing on specific bodily feedback. The actual feedback in turn complexified the (in hindsight simplistic) idea that a leg can go straight up, which one can imagine with a skeleton. In the fully fleshed body SMS discovered that the knee can swing out to the side when the hip rotates outwards, so that the foot's sole turns upwards toward the head. Thus, a feature that was "wrong" in the initial image construal was modified to reflect what the actual body had to do. By imagining the skeleton again SMS now realized how the ball joint of the hip might be used to the fullest; in turn, new degrees of freedom to be explored were created when exploring these micro-movements.

The exercise cycle was then completed through a round of instructions to focus on full-body attention again (i.e. without interpolation with the skeleton image). SMS now focused on imagining what the sole gently touching the forehead would feel like. This way of using imagery primed him for a more kinesthetically oriented approach to self-exploration. It facilitated a gentler approach to his movements and he eventually succeed to bring the leg almost to the head (but nourished by insights made while imagining the skeleton).

To recap, the vignette highlights an exercise in which literal and figurative images were combined to solve a classical "movement puzzle" (Clark et al., 2015). Movement trials and imagistic instructions gave direction to one another. A specific insight is that feedback from the real body and the imagined "model body" of the skeleton image closely worked together in a dialectical to-and-fro between refinements on both ends. Just as movement exploration provided a more detailed perspective on the skeleton image, the image suggested details of where and how to explore the body. Setting into correspondence an imaginary skeleton with the real body (while exploiting their basic isomorphism) allowed SMS to explore ways of effecting a transfer of operations successfully undertaken in the imaginary space into the actual body. It is important to emphasize that the sensate body had to be attentionally *construed* in terms of what was focalized (and how) while undertaking parallel construal operations in the skeletal image. Once the two became sufficiently coordinated the different parts of the exercise were able to amplify each other. The direct somatic instructions and the "non-literal" skeleton image now provided complementary resources for the problem-solving process.

This case contrasts in fascinating ways with the metaphoric vignette 1: It would seem that a reduced skeletal body model is a figurative image of sorts (it is certainly no "simple" movement instruction). Yet, it does not conform to the definitions of a metaphor or analogy either, since no non-body formatted domain is "imported". Sources and targets are so similar that no counterpart connections need to be worked out separately; they are already part of the body model anatomy-savvy somatic practitioners have of themselves. The task difficulty here rather relates to keeping two somewhat similar and thus easily aligned "spaces", that of the fully sensate body and that of the reduced skeletal image, co-present in attention and keeping their dialogue alive. Rather than a metaphor, linguists might liken this to a *part-for-whole metonymy*, based on the substantial overlap or even partial identity of source and target space, but this idea goes only so far. In reality, the example exemplifies a complex conceptual and somatic integration process, a genuine "blend" (a type of cognition which we will briefly discuss in section 5.)

4.3. Vignette 3: Taichi

Practice context: Taichi is a Chinese martial arts system emphasizing somatic self-organization of a subtle inner kind. It is practiced in both solo and interpersonal forms that span health, meditation, and combat applications.
Aims & meta-pragmatics: Learning a technical principle that allows coordinating one's body to effectively interact with an opponent
Image/source: Figurative imagery: "draw the bow and release the arrow", embedded in specific movement instructions (direct imagery) and extended practice and self-experience
Timescale: Several months
Analytic summary: The vignette highlights

- Making sense of figurative imagery in relation to prior knowledge and acquired skills in the wider context of self-learning, group learning, and conversations with teachers

- Processes of dealing with imagery that does not make sense initially; misinterpretation of counterpart connections and re-visiting meta-pragmatic assumptions (task re-interpretation and re-construing the image to resolve conflict)
- The cyclic nature of how imagery and bodily construals modulate one another in action

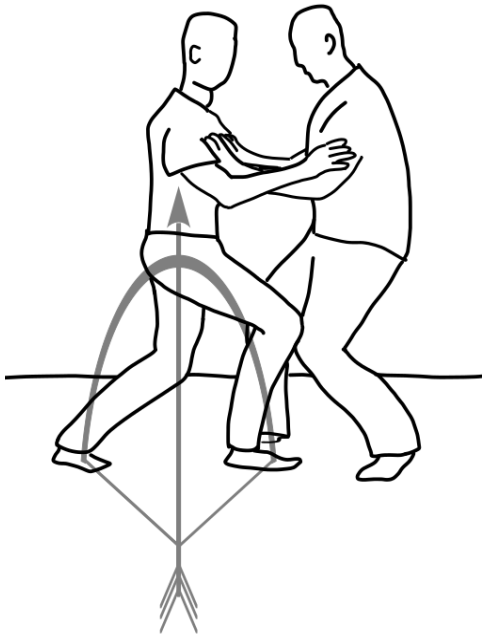

Fig. 4. The "drawing the bow" image applied to the interpersonal push hands context.

This vignette illustrates introjection-based learning over several months, again experienced by SMS. Its objective was to grasp an advanced technical principle that allows generating and issuing "relaxed force". To facilitate the learning of this principle, teachers proposed the analogy of drawing a bow and releasing an arrow (i.e. figurative imagery, as in vignette 1).

When Taichi teachers speak of "issuing relaxed force" this refers to a complex movement regulation skill that allows the pushing of the training partner with minimal physical effort. In the canonical practice scenario, one stands opposite the opponent, placing the hands on their chest or their folded arms, to train a *two-step dynamic*: (1) One first shifts the body center down and forward by bending the knees, yet without increasing pressure through the arms, and (2) then extends the legs and transmits the body extension forward through the arms to push the opponent. Technically speaking, the attacker shifts the center of gravity below the opponent's, ideally so subtly it is not noticed, and from this advantageous position pushes the opponent through the large muscles of the legs. The coordinative subtleties of this dynamic are challenging, and the analogy/metaphor of drawing a bow and shooting an arrow is commonly used to provide an intuitive "feel" of this dynamic.

SMS, in the multi-month process of making sense of the instruction, tried several interpretations and counterpart relations from image to body before he could successfully incorporate the instructed image. He could already build on some familiarity with the core dynamic he had acquired through solo exercises, a sequence of lowering the body center and raising it again to build up/load "energy" and release it in an alternation of contraction and expansion, akin to breathing. However, he experienced several challenges. Initially this related to the specific mode of executing the pattern, since teachers advised not to use effort to bend the knees or push against the floor, but to fully give the body to the pull of gravity, build up elastic energy in the legs "like a spring" (another metaphor), and then release the built-up tension to extend the body again, hence using "passively" stored energy, which initially seemed counterintuitive. Learning this skill required SMS to "bracket out" everyday intuitions to the effect that pushing oneself up needs to be effortful. Instead, he trained a dynamic of releasing of stored energy potentials without holding back anything and without active effort. Further, the aspect of letting gravity exert its pull to build up potential energy required a perspective shift. At the level of his bodily explorations, he was motivated to search for and experiment with previously unnoticed possibilities for letting go with the legs and lower body, instead of trying to control it as active movement. As a result, he identified candidate patterns of elastic stretch to build up in his legs that appeared to match the instructed building up of potential energy. He was thus able to discover movements that matched the initially paradoxical instruction. After an extended practice period this dynamic became a habitual element of his Taichi movement repertoire.

However, there was more to "draw the bow and release the arrow" metaphor given that it was supposed to be incorporated into the Taichi practice of pushing an opponent with "relaxed force". To do so, SMS had to grapple with another

problem, namely to match image components to aspects of the interpersonal coordination setting. His first approach to interpreting the metaphor was based on his childhood experience with holding a bow, pulling the string, and releasing the arrow to shoot into the distance. When he tried to apply this to the interpersonal pushing scenario some image aspects seemed to match the previously trained dynamic of "relaxed force" well: (a) a force logic consisting of two steps, building of tension and releasing it, and (b) the familiar kinesthetic quality of effortful pulling of a bow and its subsequent release. However, (c) the specific spatial and topological alignment of image components comprised a third aspect that seemed harder to make sense of. In "push hands" practice, force is transmitted horizontally from one person to the other. It was intuitive to assume that this is represented by the horizontally shot arrow – this, unfortunately, conflicted with the vertical direction of bodily sinking and rising. SMS was facing an apparent clash between the general exercise instructions and the metaphor. In the attempt to resolve this central conflict, other components of the metaphor had to be interpreted: What really represented the arrow – the force that is "shot at" the opponent, or the opponent who is "shot with"? Further, which bodily features represented the vertically aligned bow?

As a result, SMS struggled for months to find fitting matches between image constituents and training body constituents. By gathering advice from different instructors he was able to identify specifying clues. The first of these was that the bow represented his body, i.e., the body of the attacker – this helped SMS to understand himself not as actively pulling, but as being the bow, and that his body would rebound for a push analogously to a bow when it is released. But as much as this made sense because of the evident match of the vertical alignment of the bow with his upright body, the persistent problem was the mismatch between the horizontal shooting direction and the previously trained vertical issuing of force. SMS attempted to bridge the gap by representing the vertical bow through his whole-body organization, and in consequence re-trained his up-down movement to include a horizontal component for a forward push (representing "shooting an arrow") through the appropriate adaptations of his leg muscles and his posture. This went on until an instructor told him that he should take care not to lean forward and not introduce too much forward intention too early. This feedback made him realize that he was using the metaphor in a way that made his technique worse, not better.

Only after a patient instructor listened to his interpretation was SMS given another critical clue, namely that the bow wasn't supposed to represent the whole body, but only the legs, and had to be thought of as lying horizontally, so that gravity pulled it downwards. Thinking of the bow like this enabled SMS to match the bow with the arc of his legs. Still, how such a presumably upward flying "energy arrow" could affect a horizontally opposed person remained a great puzzle. The image interpretation seemed more coherent now, but it remained hard to bring it fully into the body and the constellation with an opponent. Finding out how the torso and arms could redirect the generated force horizontally required suppressing some mismatching aspects of the (apparently underspecified) instruction. It seemed that the force trajectory apparently had to "make a bend" forward, so SMS concluded that he should begin to experiment with a hybrid image with the bow located in the legs and pointing upwards, but the arrow then making a curve to flying forward horizontally.

Finally, an instructor added a decisive piece of the puzzle: "Think of the opponent as the arrow, which you draw and release; and you never run after the arrow to push it further forward". Applying this feature made SMS focus on how to "draw" the attacking opponent towards him through subtle encouragement. This interpretation of the metaphor provided much greater focus on actions preceding the force release. It encouraged embodied experimentation with how the forward moving opponent could be controlled through the contact point on the arm, analogous to the hand that pulls a bowstring. This new and extended focus on the full ensemble of movement phases connected the two bodies in a joint dynamic even before releasing the energy. This resolved the puzzle, and the case description ends here, but as SMS reports, he had to practice this dynamic further until it became fluent.

To recap, various image features had to be integrated and applied in just the right way to gain the ability to push without any effortful use of the arm muscles and without leaning into the opponent. In the process a complex imaginative gestalt had to be effortfully dis-assembled and re-assembled, with one image feature being rotated by 90°. This learning process was not linear. Several red herrings had to be discarded and misunderstandings between SMS and the instructors cleared up. The learning process was one of gathering clues and experimenting with new ways of executing movements, while adapting how the metaphor was understood, reconfiguring image constituents. Linking these image constituents to the right set of body parts and functions was essential to success. The learning process that SMS underwent included several stages of recursive refinement, which moved back-and-forth between interpreting the metaphor and practical trials. This process was dialectic: Movement experimentation in light of the initial verbal cues suggested a need to re-interpret the metaphor, making new image features salient while suppressing others as irrelevant; these changes in turn triggered new forms of physical experimentation, which suggested yet further possible matches between metaphor and the felt body. Over time both the image features increased in internal consistency and matched better with movement feedback and the specified task aims. The vignette also illustrates that any metaphor underspecifies a complex movement skill and previously acquired skills have to be integrated, just as new ones that arise in the process do. The example also shows just how easy it is to introject in a normatively "wrong" way if context is insufficient or the instructor's intention is misread. Metaphors can be incomplete or not fully "logical", while instructors often leave it to the pupils to figure out "what matches with what". Finally, the right meta-pragmatic approach to the task was crucial for overcoming this impasse, as SMS at some point told himself not to be bothered by mismatching features ("don't think about it further, this is not what the task is about").

4.4. Insights from the case studies

We are now in a good position to re-examine our three empirical analyses in light of the theoretical framework proposed in Section 3. Our process analysis addressed ways in which introjection is a complex sense-making dynamic. We specifically looked at how it co-orchestrates linguistic, imagistic, attentional, and sensorimotor faculties and what the impact of practice contexts, task aims, as well as personal preferences is. For understanding how introjection works, our granular process-analytic lens is a major step ahead because it traces the many small contributing acts that the process may be composed of, the adaptations that need to be undertaken or obstacles overcome, and how perspectives on the task itself develop over time.

The process-analytic approach validated our claim that convergent enactions allow capacities situated at different poles to progressively align. Our case studies demonstrate coordinated activities on multiple fronts, both "mental" and "physical". A person can manipulate the image itself just as much as she manipulates the body through attentional or movement explorations and posture changes. These two poles are part of a complex work-sharing process and modulate, trigger, inform and constrain each other. The mind construes the image while the body convergently explores, moves, and is attentionally calibrated, or conceptualized to "attract" this mental pole of imagery.

Our process analysis also confirms our claims about recursiveness. It illustrates just how *temporally* braided the different sub-processes can be. Albeit placed at different timescales, all our examples include refinement and recursive interpolation between image, task, and body exploration. The fish movements in the dance vignette illustrate how an image is developed during the movement, taking up cues from the sensorial feedback. The Taichi vignette similarly shows that first actions can happen while a person is trying to interpret the bow and arrow image in different ways or that images can create the first bodily effects, long before all facets of the image have been grasped in their integral implications. Furthermore, the process analysis also highlights the *causal* interdependence of processes on both poles. There is a certain task holism making it ineffective to orchestrate each pole too independently or obliviously to task constraints (i.e., one will not likely spend time on aspects of the input image that seem at cross-purposes with the task).

In addition, we have been able to pinpoint further characteristics of the introjection process. Since all of our examples are about discovery or learning, sense-making takes the form of elaborate "embodied problem solving", a dynamic of figuring out a solution that happens in the body itself as well as the image, and more importantly through working out the mutual relationship between these two "spaces". We have shown how this can involve recursive micro-cascades of probing, experimenting, "as if" construals in the mind, and sometimes developing the image mentally before applying it to the body (i.e. composing and co-orchestrating image elements offers rich resources of sense-making, as learning researcher Parnafes (2012) also demonstrates).

Furthermore, our case studies highlight just how context-bound the introjection process is. What the three practitioners did reflected in many different ways their previous explorations and self-experience, i.e. highly idiosyncratic processes that are impossible to generalize. Another aspect that is probably easier to generalize was the strong influence of what we call a *meta-pragmatic orientation* which cognitively supervises one's own practice, defines aims and determines what counts as success. The dance example was about exploring as many ways as possible of using an image as an inspiration; the Feldenkrais example was about using a heuristic to discover ways "to loosen up", although in a relatively difficult task; and the Taichi example followed a strict technical goal with narrow success conditions. The meta-pragmatic orientation reflects the specific kind of normativity of the task and, in turn, the practice philosophy of the domain. The dance vignette is largely open and creative, whereas the Feldenkrais task has a definite aim yet encourages open experimentation, and the Taichi task has a highly specific aim and teachers encourage specific forms of interpreting the images as well as specific training exercises.

This is reflected in how constrained the micro-processes of introjection are. Creative dance and to an extent Feldenkrais allowed for a playful and free interplay, as inspirations both from image and the movement experience are picked up on. The Taichi technique with its clearly defined yardstick of effectiveness ran back-and-forth between image adaptations and somatic adaptations, which produced strong constraints at each stage that forced the rest of the system to adapt in due course. Note also that the process logic differed in interesting ways: In the Taichi example, the key aim was to improve the alignment between movement aspects over multiple cycles, whereas in dance different stages of "local" sufficiency followed upon each other, given the freer constraints.

A final insight concerns the necessary *background of skills and habits*. In our vignettes deliberate attention to the specific task operated against more implicit skill backgrounds, which body phenomenology alerts us to. There is a complex relationship between working with adaptive habits and transforming mal-adaptive ones, e.g. by accessing zones of sensorimotor amnesia (Behnke, 1997). Thus, all three cases displayed a continuous working with and enrichment of previous experience, although in Taichi habits were also in need of being deconstructed and in the Feldenkrais example dissolving habitual tensions was a necessary step for success.

5. Discussion

In this section we will turn to broader implications for embodied cognition by looking at introjection from different, but complementary theoretical angles.

5.1. Introjection as mind-body alignment

Our study uses the attributes "bodily" and "mental" in a somewhat heuristic sense to differentiate sub-processes of introjection. Thus, not yet fully understood imagery cues fall to the more mental pole at first, before they acquire embodied "my-ness", whereas spontaneous movement before imagery falls to a more bodily pole. On the basis of this particular way of thinking, we treated body and mind as dialectical partners and interacting poles of a dynamic whole, which are not a priori fully integrated. Introjection is best seen as a search for mind-body alignment, frequently via states of partial dis-alignment. We follow Giovine (2022) here, who emphasizes the dynamic character of the mind-body relationship, its capacity to "be experienced as attuned or disattuned" (p. 5). Giovine develops a non-dualist, yet non-conflationist perspective that is highly compatible with our view of the mind-body relationship. Sufficiently "attuned" mind-bodies do not, as a rule, come for free. What follows from this perspective is a necessity to actively forge, maintain, and cultivate this relationship. Accordingly, we have described processes of sense-making that require effort, active orientation, as well as skill, and that can succeed or fail.

The many ways in which disattunement of source images and situated bodies may occur throws into relief the contingent nature of introjection. Firstly, learning to use imagery may require acquiring sensorimotor know-how before the full range of an image can be appreciated. Imagery evoked by a verbal cue may be tentatively comprehended, yet lie outside one's personal scope; it can notably pick out body properties that a person cannot yet locate, feel, or move at will. More generally, language never fully captures a sensorimotor skill; words need to be enriched by experience itself. Unsurprisingly, many somatic insights presuppose developing new skills to enact them. Even mentally fairly well understood images may require calibrating new muscle synergies. There are "mental-only" ways of understanding imagery that do not yet reach the body.

Complementarily, potential error sources in "language-unpacking" may occur. Metaphors in particular – since they are not "body-formatted" – are known to frequently appear ambivalent or unclear. They are prone to misattribution of image features to unsuitable body elements or using features in a way that will not achieve the desired outcome. Finally, all imagery may need to be actively worked with in productive ways. For example, a learner might initially translate verbal cues into too static movement "snapshots" that neglect smooth transitions.

The combined weight of these observations is what makes us think that introjection is a complex and error-prone process of sense-making. A common-sense objection to this idea is that at least direct sensorimotor cues seem to directly and often swiftly induce bodily effects. Although habitualized introjections that have been performed many times before appear "seamless", we argue that they are based on established links between a verbal cue, image, and a movement, e.g. "lift up your right arm" or "grasp the pencil". However, even simple expressions like these do not provide full-scale action specifications. Actions can be implemented in different ways, e.g. either by the hand, and even the feet or mouth. Verbal cues invariably require situated interaction to fill in the details.[8] So while it may be tempting to think that simple movement instructions just activate action schemas for a canonical body part, processes of actively figuring out what fits the context are easy to overlook. Even with habitual cues and well-rehearsed standard movements there are many ways of responding to situated specifics and feedback received during the process. A body cannot *automatically* match verbal cues to "standard" features; it can at best have a habitual preference that needs to be negotiated or fleshed out in view of the context.

More importantly still, introjection practices in dance, martial arts, or sports are typically about de-habitualizing stereotypical patterns or learning new ones. Familiar movements or sensations are infused with new features or variations explored, such as lifting an arm with a slight rotation or combining it with other movements. Unfamiliar action features may be blended with familiar ones or familiar ones assembled in new ways. In yet more complex cases, completely novel forms of activity are realized so that an effective language-image-body relation needs to be built *de novo*. This includes cues in which imagery elements need to be made mutually coherent (e.g. connecting two small movements so they synergize) and even such that combine familiar elements in ways that initially seem to clash.

Irrespective of this we do not deny in any way how wide-spread introjection expertise is even in non-experts and children, who often readily respond to well-chosen imagery cues. Thus, the skills or practice substrates they draw on to achieve this remain an important question for future research.

5.2. Introjection as situated body performativity & body conceptualizing

It is worthwhile emphasizing that introjection "rides on" fundamental ways in which individuals relate to their lived bodies. Our starting point was to stress the body's eminently active role. Cultural phenomenology confirms this in its emphasis that the body is continuously *performed* as an existential ground (Csordas, 1994). Thus, bodies are not only enduring structures, but also made sense of within a situated intentionality depending on how a person or group is oriented in relation to their context. How people somatically enact themselves from moment to moment is a key aspect of the human self-world relation (Durt, 2017). Bodies enter context-specific *somatic modes of attention* (Csordas, 1993) and readiness states. Even when they ostensibly do nothing, tiny enactments of sensitivity, attention, or exploratory orientation happen that impart a specific

[8] This is most evident in the case of schematic imagery, e.g. so-called "kinetic melodies" (Sheets-Johnstone, 2007) that can be executed by different actuators and attach to no specific body part. It is less evident in the case of canonical action concepts such as "grasping" or "kicking". However, these too have a certain degree of flexibility, e.g. can be combined and executed in many different ways, as language always underspecifies movement. The meaning of a word like "grasp" specifies no more than outcome parameters, whereas details of movements are usually developed through the perceptual feedback loop with the context and, often, with ongoing re-afferences while one acts.

receptiveness. The most evident performative act is moving one's body, but subtler performativity also occurs as a person context-specifically orchestrates reflective attention to the body.[9]

A basic facet of body performativity is the unique propensity of the sensorimotor system for being imbued with imagery (Jeannerod, 2004). Imagery processes supervene on body reflectiveness in ways the terms attention or perception fail to capture. We do not only perceive our bodies, in doing so we also frequently evoke the body's potentials, configurations, ideal states, and next actions. Actions are guided through idealized imagery, and sensorimotor process can, for example, be enriched through imagined ideas of axis, balance, or spatial geometry configuration (Kimmel, 2012). Additionally, body percepts are very naturally augmented through hidden features, e.g. when a health practitioner projects anatomical knowledge of hidden organs into what is seen (Kimmel et al., 2015). We may conclude that the relationship of humans to their bodies is just as imaginative as it is perceptual. The lived, pre-noetic body (Bower and Gallagher, 2016) is seeped with imagery much of the time, which gives motivational pull to our actions and being, as well as being useful for regulating skilled action. We believe that embodied self-experience, even prior to language, is subject to context-bound perspectivization, salience operations, and global organization (e.g. integration between parts into a functional whole). Bodies also include "as if" potentials, which Berlucchi and Aglioti (2010) reclaim as an inherently imaginative component of body representations.

The next step in our argument is as follows: When we produce somatic imaginings that make bodies objects of intentionality the body is not simply made reflective in attention, but frequently also *conceptualized qua body*. There is evidence of internal body models (Bläsing et al., 2010), even if real-time body perception may fulfil similar functions (Hoffmann, 2022). Conceptualizing features such as bodily actions, appearance, structures, or functions is a fundamental way to coordinate the self-world relationship, although we would rather not get into the intricacies of the *body schema* vs. *body image* debate (see Gallagher, 2005).[10]

In our case studies we find several examples in which introjection very clearly exploits body conceptualizations. In our dance vignette the feeling of a cold area of the pelvis led to a conceptualization of this body part as target for a particular "as if" conceptualization. Similarly, in the Feldenkrais vignette a reduced skeletal re-conceptualization of the body was created. This was what allowed operations such as detecting a mismatch between actual and required body position to be performed in the first place. Evidence of this sort suggests that how persons relate to their lived bodies involves *situated body conceptualizations* (e.g. Neemeh et al., 2021). Although details await further research,[11] the notion describes a type of online body process, following Carruthers' (2008) distinction in which "an online representation of what the body is currently like […] is an explicit conscious representation" whereas the offline representation "represents what the body is usually like" (p. 1314). Relative to long-term body representations[12] such online representations arise as a temporary process that supervenes on and enriches the former.

At present, our claim is that generating productive *situated body conceptualizations* is fundamental to performing complex introjection tasks. The situated body conceptualizations that introjection works with are part-and-parcel of the many layers of body cognition that humans can explore, following De Preester (2007, p. 380) who emphasizes the "various ways in which the body can be used, in the same way as paint, brush or canvas can be explored in regard to their possible use". This emphasis on layeredness also chimes with the neuroscience perspective of Berlucchi and Aglioti (2010) who posit a "multicomponent organization of body knowledge" (p. 28), with "many bodies" in the brain (yet, not isomorphic with the body itself). Finally, these ideas fit nicely with the evidence that introjection can trigger transformative processes in multiple ways, from autonomic to elaborate intellectual processes.

It is true that the body possesses a unique logic and topology. Yet, in many respects situated body conceptualizations have the same gestalt invariants that govern imagery of "things in the world" and are therefore amenable to similar *construal operations*. The latter notion was coined by Langacker (1987) who proposes that language triggers conceptualized "scenes" and that the specific semantics make us imagine in specific ways. Different linguistic constructions can induce mental gestalt operations such as picking a particular perspective or a fitting degree of zoom, performing foreground-background switches, highlighting components or their relations, assuming a process or an end-point focus, as well as composing or assembling images. Cognitive research on imagistic thinking tasks supports this perspective, where particular reasoning practices presuppose particular construals (Schneider et al., 2013; Parnafes, 2012). Hence, when a situated body conceptualization is created, similar imagistic processes can occur as in language processing. We can construe our bodies from different perspectives or with a particular focus, making salient specific parts, relations or pathways, zooming in on substructures, or with

[9] This can, for example, mean expanding bodily awareness, elevating aspects of "subsidiary" awareness (Nyberg, 2015) or even blind spots to the foreground, discovering relations (Behnke, 1997; McIlwain and Sutton, 2014), or perceiving smaller "hints" emerging from the pre-reflective background which may trigger reflective processes. In complex tasks, attention may shift several times, e.g. between action process, action result, inner body state, and environment (Bernier et al., 2016).

[10] The debate, as Berlucchi and Aglioti (2010, p. 32) note, is tricky due to "the persistent use of vague concepts […] the definition of which varies conspicuously and confusingly from author to author".

[11] One of the challenges is not to get entangled in representational traps. One possible error of this sort is to propose a "virtual body double" different from the "real body". Another trap is to overplay functional separation, as pre-noetic action-related and conceptual processes mutually update each other (de Vignemont, 2010; Pitron et al., 2018; cf. also Carruthers, 2008).

[12] Haggard and Wolpert (2005) describe these as structures representing general spatial properties such as limb segmentation, hierarchies between them, configuration in space, and shape of body surface. Schwoebel et al. (2004) speak of a "body structural description," a topological map of locations derived from visual input that defines body part boundaries and proximity relationships (after Buxbaum and Branch Coslett, 2001; Sirigu et al., 1991).

a specific relational organization (e.g. when creating muscle chains). This implies that construing the body in a productive way for the task can either license or inhibit introjection.

All in all, an attractive feature of the theoretical notion of *construal* is that it helps us to integrate different aspects of the introjection puzzle and hereby bring somatic, phenomenological and linguistic scholarship into a closer dialogue. We see a certain symmetry between general language processing and what we might call body processing, given that perspective changes and other construal operations apply in somewhat similar ways to making sense of the input image and to making sense of the body. By highlighting this important symmetry with respect to imagistic operations we come to understand how a common ground is provided for different sub-processes of introjection to be fluidly co-adapted. With respect to our model we could say that two context-motivated construals, of source image and body respectively, need to be coordinated.

5.3. Introjection as constructive-compositional process

We have showcased complex conceptual processes. This includes secondary image elaborations in vignette 1 on dance, blends with an "as if" reduced version of the body in vignette 2 on Feldenkrais, and complex meshing of introjection with other learning inputs and practices in vignette 3 on Taichi. All this suggests that sense-making, frequently, involves not only sensorimotor, but also constructive conceptual processes. Establishing "productive enough" counterpart connections or isomorphisms between source and target is such a conceptual process, since it requires co-adaptations of body attention and imagery construal with actual movement explorations. This insight offers an argument against a "natural" transduction of language inputs to actions, and all ideas of "direct infusion" according to which imagery can impinge on the sensorimotor functions of the body without mediation. This is a position towards which non-representational approaches seemingly gravitate (Abrahamson et al., 2016; Jensen and Greve, 2019; Rucińska and Gallagher, 2021). While we share their curiosity about enactive theory and their deep commitment against "mind-only" explanations, their non-representational species of explanation underspecifies introjection contexts. We have identified a range of empirical facts about introjection, which a direct infusion view has trouble accounting for:

- There are always alternative ways of making sense of either the image or the body, and different ways to interlink them, implying that situated decisions are made.
- All introjection has either implicit or explicit normativity. In some contexts, a wide range of errors may occur, thus non-sense in the process of sense-making (see vignette 3).
- Embodied problem solving is involved in much introjection, e.g. figuring out initially counterintuitive inputs or developing motor skills to explore deeper layers of an image.
- Intense meta-cognitive self-guidance may be required to keep an introjection task constrained. For example, imaginative augmentations of the perceptual body need to be laboriously maintained, updated, or transformed while dialoguing with one's manifest physicality.
- Processes of composing and transforming imagery frequently occur such as integrating different imagery features into a single model or "running" the image in different ways. Instructions are frequently multi-aspectual (e.g. combine multiple metaphors) that gradually add up to an integrated imagistic model.
- Figurative imagery further adds to the conceptual requirements. In a metaphor the input is, by definition, "not easily fitted" to the intended context, but must mentally be "made to fit". This presupposes sophisticated and representational language processing mechanisms.

In view of these findings, we may conclude that bona fide representational activity is needed in various capacities: for making sense of input images, for the process of linking images to the body, for the process of managing this as an integral task, as well as for how we relate to the body itself in imaginative ways, in order to make a situated body conceptualization a conversation partner for the mental image.

5.4. Combining cognitive linguistic & enactive-dynamic insights

Given that we highlighted just how multi-disciplinary the topic of introjection is, it is helpful to explicitly evaluate the contributions of different influential strands in embodiment scholarship.

A cognitive linguistic perspective highlights linguistic meaning construction relative to the body as a resource of sense-making. A body "space" with its particular situated invariants needs to be set into correspondence with the source image, which is interpreted in relation to this "space". Cognitive linguists also provide us with a set of questions to ask; e.g. which structures and relations are shared by the source image and the body, what is salient in them, which features clash between the two, and so on – how intuitive a verbal cue is and what strategies get adopted in the search for alignment will respond to these basic criteria. However, despite their useful analytic framework, cognitive linguists have largely neglected introjection. The putative reason is that they mean something different when they talk about the embodiment of language. While they stress how linguistic meaning *emerges* from perceptual and embodied experience introjection runs in the inverse direction,

with regard to how words come to resonate in a concretely situated and phenomenologically saturated somatic experience. Cognitive linguists might respond that word meanings arising from sensorimotor simulations can "symmetrically" re-trigger their source when used, but this is a red herring in this context. The mere ability to create perceptual simulations when processing words does not nearly ensure sufficient embodied "my-ness", which is what defines successful introjection. Therefore, claiming that "language is inherently embodied anyway" amounts to a pseudo-explanation that neglects the specifics of our explanandum. Another problem with cognitive linguistic approaches is that they frequently reduce their own scope by focusing on "mappings" between source and target spaces, a uni-directional parlance which potentially underplays the active performativity of the body target (Łozińska, 2021 is an example). Again, the cognitive linguistic perspective lacks a sufficiently performativity-oriented and phenomenological conception of embodiment.

A useful corrective for these limitations lies in perspectives on learning developed in Vygotskian psychology, which speaks of mediating embodied scaffolding and "dialogues" (Shvarts and Bakker, 2019), which offer a broader framework for understanding the operational mode of introjection. Language offers a powerful means of scaffolding for sensorimotor cognition. Somatic imagery mediated through language can be seen as providing scaffolds for perception and action that augment the more basic "real-world" processes. When a person uses imagistic skills this is a self-scaffold, and, a fortiori, when skills are trained in communities of practice, both self-scaffolds and interactive scaffolds are used.

Another fruitful impetus comes from the philosophical framework of enactive cognition after Varela et al. (1991) who claimed that "perception and cognition depend upon a person's interactions with the world" so that cognition operates through continuous coupling with external dynamics. Enactivists coined the idea of interactive processes of sense-making (Di Paolo et al., 2017), both in talking about external adaptation to the world and in terms of regulating internal organismic processes. We might apply this to introjection by saying that embodied practices can use language as a tool to improve internal regulation details in ways that make a person more capable and adaptive at the level of world interactions, i.e. "skills". The enactive perspective also posits a dynamic coupling (Gallagher and Lindgren, 2015) that interconnects brain, body, and environment. This offers a broad and useful framing for the processes we have sketched, especially the fact that introjection needs embedding in situated embodied activity. Bodily enaction that is geared towards interaction with the world is evident in subtle ways even in situations such as inner rehearsal or when a person merely embraces an orientational stance towards a task context. Therefore, we suggest placing introjection into the broader context of enactive sense-making of agents in their ecology. As Jensen and Greve (2019) argue, metaphor – and the same can be said for any kind of introjection cue – is part of "cognition as a skull-and-body-transcending activity which is deeply entangled with the environment" and that "metaphor is a product of an organism-environment-system" (p. 1). Enactive approaches to language look at the "corporeal logic of what is involved in the activity of using and enacting language" (Di Paolo et al., 2018, p. 133). This framework rightly emphasizes that words are tools used to constrain interaction processes. Similarly, scholarship in ecological dynamics defines metaphor as a *constraint* on the sensorimotor system (Abrahamson et al., 2016, see Section 2). The merit of this is to highlight that linguistic triggers are never fully specificational and that the body has its own resources of sense-making.

Despite providing a broader framework, the discussed approaches require a circumspect evaluation. Abrahamson et al. (2016), when they speak of constraint-based sensorimotor effects, reflect the tendency of ecological dynamics to globally look at how learning follows verbal intervention, while neglecting smaller thinking processes *on the way*. In contrast, we have illustrated how much is to be gained from zooming in on the re-working of imagery or inferences made through imagery *before* the next round of sensorimotor testing. Furthermore, Abrahamson et al. (2016, p. 315) explicitly critique that "[c]ommon theoretical models treating the curious phenomenon of metaphor will have us believe that the student internally builds structural alignments between source and target domains". We would respond that the authors are quite right to question the purely internal locus of sense making, but are prematurely rejecting the alignment and source-target perspective. Our own model would speak of alignment that arises in the recursive interplay of sensorimotor processes and linguistic ones.

The general bone of contention, of course, is whether mediating conceptualizations are needed. For example, Di Paolo et al. (2018, p. 295) critically question the need for "putative internal representations" and train their sights on symbolic practices occurring in a public, interactive capacity. Yet, constructive and conceptual operations evidently continue to do explanatory work when understanding complex phenomena such as introjection. We cannot simply neglect image transformations or fail to distinguish aspects such as word processing from the context-bound sensorimotor activity itself. Instead of parting company with representational assumptions completely, we emphasize the need for a *phenomenology of embodied thinking practices* as part of meaning making, which pays attention to constructive and compositional processes sitting in the nooks and crannies of the (inter)enactive event such as selective feature alignment and trying out different image construals.

This is why embodied semantics and theories of analogy continue to be an asset. To describe introjection processes it helps to have at one's disposal an analytic language of separate spaces, selective counterpart connections, isomorphism-based constraints on the linkage, and situated conceptual construals that constitute meaning within each space. None of these ideas commits us to the undesirable conclusion of word meanings "simply being mapped" to the body. In fact, interactionist perspectives on metaphor in cognitive linguistics recognize that sources and targets exert mutual selective constraints before inferences can emerge. They acknowledge that sources are *selectively* used in the light of the target's existing structure and that the target has the power to direct features (cf. *invariance principle* in Lakoff and Turner, 1989). This interactionist outlook

is most explicit in conceptual integration theory (Fauconnier and Turner, 2002), which postulates co-projections into a temporary working space where selective affinities are built.[13]

To sum up, we have analyzed introjection as a continuous and multi-polar integration process, a context-sensitive braiding of body-semantics and the lived, enacted body. What we preserve from accounts such as those of Gentner, Lakoff, or Fauconnier and Turner is the practice of specifying counterpart connections between (a priori separate) mental spaces – a best practice many recent contributions sadly neglect. However, we re-frame linguistic activity as a context-sensitive process happening within a dynamic body and a dynamic external ecology. Thus, our approach sits right between ecological dynamics/enactivism and cognitive linguistics.

6. Conclusion

Introjection is a powerful way in which mind and body enter into conversations. It is a genuinely multi-polar sense-making activity that possesses great possible payoffs in learning, performance, re-habituation, rehabilitation, meditation, therapy, and creative contexts.

Sports and dance psychology, neuroscience, and body phenomenology, have addressed the mechanisms underlying this, and cognitive linguists have proposed useful general models for understanding conceptual operations, but comparatively little is known about the actual processes of introjection. To step into the gap, we have presented a qualitative inquiry that pays close attention to how different micro-processes are co-orchestrated, giving equal weight to attentional, sensorimotor, imagistic and linguistic aspects. Our examples traced how these enter into a conversation, illustrating the recursive and often effortful nature of this process, as well as possible obstacles, and the fact that many of the most interesting examples can be rightfully considered as *embodied problem solving*.

In introjection, the body is no inert receptacle for words, but becomes a site for active performativity and learning, in which perception, action and imagery blend, by actively working with reflective attention and situated body conceptualizations. Nor is introjection mainly a mental event of just establishing counterpart connections that can always be straightforwardly realized on the spot. To advance the debate we need a multi-polar and dialectic theory of how body and mind engage over time, co-adapt and, if this succeeds, become aligned.

Importantly, this explanandum is interdisciplinary and withstands reduction to a single species of theory, since it brings sensorimotor coupling into interplay with conceptual operations. An analysis of the latter is needed, inter alia, to explain subprocesses such as extraction of schemas, selective feature alignment or “blended” effects between perception and imagery. Embodied simulation theories can be a great asset here, as can linguistic work on construal operations. This notwithstanding, we see an equally pressing need to “enactivize” our analysis by reinserting the mental operations into the sensorimotor coupling loop a person experiences. We thus need to consider an active situated agent who moves, explores, and assumes a particular stance towards the body as she engages in embodied problem solving.

In terms of methodology, we have advocated a detailed research of situated process trajectories, set against the backdrop of individual skills and habits as well as the more general domain aims and practice constraints. This processual perspective with a high zoom factor has helped us to make first steps towards a framework that specifies possible operations, strategies, and sources of task difficulty, which will equally cater to the concerns of practitioners and embodied cognitive science.

Finally, we believe that a perspective on introjection *as a progressive alignment process* can provide a good test-bed for embodiment theory and its central ontological dilemmas. Introjection paradigmatically exemplifies how body and mind become dynamically co-dependent, i.e. augment as well as constrain each other. Our processual analysis of how these facets of cognition dynamically connect over time helps us avoid mind-body dualism, yet also steer clear of an unproductive conflationist position that just amalgamates mind and body, rather than looking at the skilful (and sometimes effortful and error-prone) act of their integration.

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Data availability

No data was used for the research described in the article.

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[13] This perspective helps us frame introjection as a kind of inference generated from conceptual, embodied and perceptual inputs (e.g., Oakley, 2009). Introjection could even be expressed by speaking of the creation of *somatic blends* in which the interplay of embodied perceptions and words creates emergent structure when “running the blend” – a potential future direction for study.

References

Abrahamson, D., 2020. Strawberry feel forever: understanding metaphor as sensorimotor dynamics. Senses Soc. 15 (2), 216–238. https://doi.org/10.1080/17458927.2020.1764742.

Abrahamson, D., Sánchez-Garcia, R., Smyth, C., 2016. Metaphors are projected constraints on action: an ecological dynamics view on learning across the disciplines. In: Looi, C.-K., Polman, J., Cress, U., Reimann, P. (Eds.), Transforming Learning, Empowering Learners: The International Conference of the Learning Sciences (ICLS), vol. 1. International Society of the Learning Sciences, pp. 314–321. https://doi.org/10.22318/icls2016.42.

Alexander, F.M., 1923. Constructive Conscious Control of the Individual. Richard Clay and Company, Ltd.

Bainbridge-Cohen, B., 1993. Sensing, Feeling, and Action; the Experiential Anatomy of Body-Mind Centering. Contact Editions.

Behnke, E.A., 1997. Ghost gestures: phenomenological investigations of bodily micromovements and their intercorporeal implications. Hum. Stud. 20 (2), 181–201.

Berlucchi, G., Aglioti, S.M., 2010. The body in the brain revisited. Exp. Brain Res. 200 (1), 25–35. https://doi.org/10.1007/s00221-009-1970-7.

Bernier, M., Trottier, C., Thienot, E., Fournier, J., 2016. An investigation of attentional foci and their temporal patterns: a naturalistic study in expert figure skaters. Sport Psychol. 30 (3), 256–266. https://doi.org/10.1123/tsp.2013-0076.

Bläsing, B., Calvo-Merino, B., Cross, E.S., Jola, C., Honisch, J., Stevens, C.J., 2012. Neurocognitive control in dance perception and performance. Acta Psychol. 139 (2), 300–308. https://doi.org/10.1016/j.actpsy.2011.12.005.

Bläsing, B., Schack, T., Brugger, P., 2010. The functional architecture of the human body: assessing body representation by sorting body parts and activities. Exp. Brain Res. 203 (1), 119–129. https://doi.org/10.1007/s00221-010-2216-4.

Böger, C., 2012. Metaphorical instruction and body memory. In: Koch, S., Summa, M., Müller, C. (Eds.), Body Memory, Metaphor and Movement. John Benjamins, pp. 187–199.

Bower, M., Gallagher, S., 2016. Bodily affects as prenoetic elements in enactive perception. Phenomenol. Mind 4, 78–93. https://doi.org/10.13128/PHE_MI-19591.

Buxbaum, L.J., Branch Coslett, H., 2001. Specialised structural descriptions for human body parts: evidence from autotopagnosia. Cogn. Neuropsychol. 18 (4), 289–306. https://doi.org/10.1080/02643290126172.

Calvo-Merino, B., Grèzes, J., Glaser, D.E., Passingham, R.E., Haggard, P., 2006. Seeing or doing? Influence of visual and motor familiarity in action observation. Curr. Biol. 16 (19), 1905–1910. https://doi.org/10.1016/j.cub.2006.07.065.

Carruthers, G., 2008. Types of body representation and the sense of embodiment. Conscious. Cognit. 17 (4), 1302–1316. https://doi.org/10.1016/j.concog.2008.02.001.

Christensen, W., Sutton, J., McIlwain, D.J., 2016. Cognition in skilled action: meshed control and the varieties of skill experience. Mind Lang. 31 (1), 37–66.

Clark, D., Schumann, F., Mostofsky, S.H., 2015. Mindful movement and skilled attention. Front. Hum. Neurosci. 9 (297). https://doi.org/10.3389/fnhum.2015.00297.

Clark, J., Paivio, A., 1991. Dual coding theory and education. Educ. Psychol. Rev. 3 (3), 149–210. https://doi.org/10.1007/BF01320076.

Colombetti, G., 2014. The Feeling Body: Affective Science Meets the Enactive Mind. The MIT Press.

Csordas, T.J., 1993. Somatic modes of attention. Cult. Anthropol. 8, 135–156.

Csordas, T.J., 1994. Embodiment and Experience: The Existential Ground of Culture and Self. Cambridge University Press.

Cumming, J., Ramsey, R., 2009. Imagery interventions in sport. In: Mellalieu, S.D., Hanton, S. (Eds.), Advances in Applied Sport Psychology: A Review. Routledge, pp. 5–36.

Cumming, J., Williams, S.E., 2012. The Role of Imagery in Performance. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199731763.013.0011.

De Preester, H., 2007. To perform the layered body: a short exploration of the body in performance. Janus Head. 9 (2), 349–383. https://doi.org/10.5840/jh2006926.

de Vignemont, F., 2010. Body schema and body image—pros and cons. Neuropsychologia 48 (3), 669–680. https://doi.org/10.1016/j.neuropsychologia.2009.09.022.

Di Paolo, E.A., Buhrmann, T., Barandiaran, X.E., 2017. Sensorimotor Life: An Enactive Proposal, first ed. Oxford University Press.

Di Paolo, E., Cuffari, E.C., De Jaegher, H., 2018. Linguistic bodies. The continuity between life and language. MIT Press.

Durt, C., 2017. Consciousness, culture, and significance. In: Durt, C., Fuchs, T., Tewes, C. (Eds.), Embodiment, Enaction, and Culture: Investigating the Constitution of the Shared World. MIT Press, pp. 65–86.

Eddy, M., 2009. A brief history of somatic practices and dance: historical development of the field of somatic education and its relationship to dance. J. Dance Somat. Pract. 1 (1), 5–27. https://doi.org/10.1386/jdsp.1.1.5_1.

Ely, F.O., Munroe-Chandler, K.J., O, J., McCullagh, P., 2020. The practice of imagery: a review of 25 Years of applied sport imagery recommendations: Journal of Imagery Research in Sport and Physical Activity. J. Imagery Res. Sport Phys. Activ. 15 (1), 20200018. https://doi.org/10.1515/jirspa-2020-0018.

Emslie, M., 2009. Skinner releasing technique: dancing from within. J. Dance Somat. Pract. 1 (2), 169–175. https://doi.org/10.1386/jdsp.1.2.169_1.

Evans, V., Bergen, B.K., Zinken, J., 2006. The cognitive linguistics enterprise: an overview. In: Evans, V. (Ed.), The Cognitive Linguistics Reader, pp. 2–36. Equinox.

Evans, V., Green, M., 2006. Cognitive Linguistics: An Introduction. Edinburgh University Press.

Fauconnier, G., Turner, M., 2002. The Way We Think: Conceptual Blending and the Mind's Hidden Complexities. Basic Books.

Feldenkrais, M., 1972. Awareness through Movement: Health Exercises for Personal Growth. Harper & Row.

Filgueiras, A., Quintas Conde, E.F., Hall, C.R., 2018. The neural basis of kinesthetic and visual imagery in sports: an ALE meta − analysis. Brain Imaging Behav 12 (5), 1513–1523. https://doi.org/10.1007/s11682-017-9813-9.

Fink, A., Graif, B., Neubauer, A.C., 2009. Brain correlates underlying creative thinking: EEG alpha activity in professional vs. novice dancers. Neuroimage 46 (3), 854–862. https://doi.org/10.1016/j.neuroimage.2009.02.036.

Fisher, V.J., 2017. Unfurling the wings of flight: clarifying 'the what' and 'the why' of mental imagery use in dance. Res. Dance Educ. 18 (3), 252–272. https://doi.org/10.1080/14647893.2017.1369508.

Frank, C., Schack, T., 2017. The representation of motor (Inter)action, states of action, and learning: three perspectives on motor learning by way of imagery and execution. Front. Psychol. 8, 678. https://doi.org/10.3389/fpsyg.2017.00678.

Franklin, E., 1996. Dance imagery for technique and performance. Human Kinetics.

Franklin, E., 2012. Dynamic alignment through imagery. Human Kinetics.

Fridland, E., 2017. Skill and motor control: intelligence all the way down. Phil. Stud. 174 (6), 1539–1560. https://doi.org/10.1007/s11098-016-0771-7.

Gallagher, S., 2005. How the Body Shapes the Mind. Oxford University Press. https://doi.org/10.1093/0199271941.001.0001.

Gallagher, S., Lindgren, R., 2015. Enactive metaphors: learning through full-body engagement. Educ. Psychol. Rev. 27 (3), 391–404. https://doi.org/10.1007/s10648-015-9327-1.

Gentner, D., 1983. Structure-mapping: a theoretical framework for analogy. Cognit. Sci. 7 (2), 155–170. https://doi.org/10.1207/s15516709cog0702_3.

Gentner, D., 1988. Metaphor as structure mapping: the relational shift. Child Dev. 59 (1), 47. https://doi.org/10.2307/1130388.

Giguere, M., 2011. Dancing thoughts: an examination of children's cognition and creative process in dance. Res. Dance Educ. 12 (1), 5–28. https://doi.org/10.1080/14647893.2011.554975.

Giovine, V., 2022. Embodying daoist internal arts: walking the line between the reification and the instrumental use of cognition. Sociology 56 (3), 574–590. https://doi.org/10.1177/00380385211044319.

Guillot, A., Collet, C., 2008. Construction of the Motor Imagery Integrative Model in Sport: a review and theoretical investigation of motor imagery use. Int. Rev. Sport Exerc. Psychol. 1 (1), 31–44. https://doi.org/10.1080/17509840701823139.

Guillot, A., Di Rienzo, F., MacIntyre, T., Moran, A., Collet, C., 2012. Imagining is not doing but involves specific motor commands: a review of experimental data related to motor inhibition. Front. Hum. Neurosci. 6. https://doi.org/10.3389/fnhum.2012.00247.
Guillot, A., Rienzo, F.D., Frank, C., Debarnot, U., MacIntyre, T.E., 2021. From simulation to motor execution: a review of the impact of dynamic motor imagery on performance. Int. Rev. Sport Exerc. Psychol.. https://doi.org/10.1080/1750984X.2021.2007539.
Guillot, A., Tolleron, C., Collet, C., 2010. Does motor imagery enhance stretching and flexibility? J. Sports Sci. 28 (3), 291–298 https://doi.org/10.1080/02640410903473828.
Haggard, P., Wolpert, D.M., 2005. Disorders of body scheme. In: Freund, H.J., Jeannerod, M., Hallett, M., Leiguarda, R. (Eds.), Higher-Order Motor Disorders. Oxford University Press.
Hanrahan, C., Salmela, J.H., 1990. Dance Images—do they really work or are we just imagining things? J. Phys. Educ. Recreat. Dance 61 (2), 18–21 https://doi.org/10.1080/07303084.1990.10606435.
Hanrahan, C., Tétreau, B., Sarrazin, C., 1995. Use of imagery while performing dance movement. Int. J. Sport Psychol. 26, 413–430.
Hanrahan, C., Vergeer, I., 2000. Multiple uses of mental imagery by professional modern dancers. Imagin., Cognit. Pers. 20 (3), 231–255.
Heiland, T., Rovetti, R., 2013. Examining effects of Franklin Method metaphorical and anatomical mental images on college dancers' jumping height. Res. Dance Educ. 14 (2), 141–161. https://doi.org/10.1080/14647893.2012.712105.
Hjortborg, S.K., Ravn, S., 2020. Practising bodily attention, cultivating bodily awareness – a phenomenological exploration of tai chi practices. Qual. Res. Sport Exerc. Health 12 (5), 683–696. https://doi.org/10.1080/2159676X.2019.1662475.
Høffding, S., Satne, G., 2021. Interactive expertise in solo and joint musical performance. Synthese 198 (S1), 427–445. https://doi.org/10.1007/s11229-019-02339-x.
Hoffmann, M., 2022. Body Schema or the Body as its Own Best Model (arXiv:2206.02438). arXiv. http://arxiv.org/abs/2206.02438.
Iacono, A.D., Ashcroft, K., Zubac, D., 2021. Ain't just imagination! Effects of motor imagery training on strength and power performance of athletes during detraining. Med. Sci. Sports Exerc. 53 (11), 2324–2332. https://doi.org/10.1249/MSS.0000000000002706.
Ietswaart, M., Butler, A.J., Jackson, P.L., Edwards, M.G., 2015. Editorial: mental practice: clinical and experimental research in imagery and action observation. Front. Hum. Neurosci. 9, 573. https://doi.org/10.3389/fnhum.2015.00573.
Ilundáin-Agurruza, J., 2017. Muscular imaginings—a phenomenological and enactive model for imagination. Sport Ethics Philos. 11 (1), 92–108. https://doi.org/10.1080/17511321.2017.1294197.
Isaac, A.R., Marks, D.F., Russell, D.G., 1986. An instrument for assessing imagery of movement. The vividness of movement imagery questionnaire. J. Ment. Imagery 10 (4), 23–30.
Jeannerod, M., 1994. The representing brain: neural correlates of motor intention and imagery. Behav. Brain Sci. 17 (2), 187–202. https://doi.org/10.1017/S0140525X00034026.
Jeannerod, M., 2004. Actions from within. Int. J. Sport Exerc. Psychol. 2 (4), 376–402. https://doi.org/10.1080/1612197X.2004.9671752.
Jeannerod, M., Decety, J., 1995. Mental motor imagery: a window into the representational stages of action. Curr. Opin. Neurobiol. 5 (6), 727–732. https://doi.org/10.1016/0959-4388(95)80099-9.
Jensen, T.W., Greve, L., 2019. Ecological cognition and metaphor. Metaphor Symbol 34 (1), 1–16. https://doi.org/10.1080/10926488.2019.1591720.
Johnson, M., 1987. The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason. University of Chicago Press.
Kapsali, M., 2016. The use of Image Schemata in Psychophysical Actor Training. Conference paper at the AISB Conference (Artificial Intelligence and Simulation of Behaviour). University of London.
Katan-Schmid, E., 2017. Dancing metaphors; creative thinking within bodily movements. Proc. Eur. Soc. Aesthet. 9, 275–290.
Kerr, C., 2002. Translating "mind-in-body": two models of patient experience underlying a randomized controlled trial of Qigong. Cult. Med. Psychiatr. 26 (4), 419–447. https://doi.org/10.1023/A:1021772324119.
Kimmel, M., 2012. Intersubjectivity at close quarters: shared, distributed, and superindividual imagery in tango argentino. Cognit. Semiotic. 4 (1), 76–124.
Kimmel, M., Hristova, D., 2021. The micro-genesis of improvisational Co-creation. Creativ. Res. J. 33 (4), 347–375. https://doi.org/10.1080/10400419.2021.1922197.
Kimmel, M., Irran, C., Luger, M.A., 2015. Bodywork as systemic and inter-enactive competence: participatory process management in Feldenkrais® method and zen shiatsu. Front. Psychol. 5 (1424), 1–23. https://doi.org/10.3389/fpsyg.2014.01424.
Kimmel, M., Rogler, C.R., 2019. The anatomy of antagonistic coregulation: emergent coordination, path dependency, and the interplay of biomechanic parameters in Aikido. Hum. Mov. Sci. 63, 231–253. https://doi.org/10.1016/j.humov.2018.08.008.
Kirsh, D., 2011. How marking in dance constitutes thinking with the body. Versus 112–113, 183–214.
Lakoff, G., 1993. The contemporary theory of metaphor. In: Ortony, A. (Ed.), Metaphor and Thought, second ed. Cambridge University Press.
Lakoff, G., Turner, M., 1989. More than Cool Reason: A Field Guide to Poetic Metaphor. University of Chicago Press.
Langacker, R.W., 1987. Foundations of Cognitive Grammar. Stanford University Press.
Leder, D., 1990. The Absent Body. University of Chicago Press.
Legrand, D.P.M., 2007. Pre-reflective self-consciousness: on being bodily in the world. Janus Head. 9 (2), 493–519.
Legrand, D., Ravn, S., 2009. Perceiving subjectivity in bodily movement: the case of dancers. Phenomenol. Cognitive Sci. 8, 389–408.
Łozińska, J., 2021. Imagery underlying metaphors: a cognitive study of a multimodal discourse of yoga classes. Metaphor Symbol 36 (3), 150–165. https://doi.org/10.1080/10926488.2021.1905486.
MacIntyre, T.E., Igou, E.R., Campbell, M.J., Moran, A.P., Matthews, J., 2014. Metacognition and action: a new pathway to understanding social and cognitive aspects of expertise in sport. Front. Psychol. 5. https://doi.org/10.3389/fpsyg.2014.01155.
Madan, C.R., Singhal, A., 2013. Introducing TAMI: an objective test of ability in movement imagery. J. Mot. Behav. 45 (2), 153–166. https://doi.org/10.1080/00222895.2013.763764.
Madan, C.R., Singhal, A., 2014. Improving the TAMI for use with athletes. J. Sports Sci. 32 (14), 1351–1356. https://doi.org/10.1080/02640414.2014.889847.
May, J., Calvo-Merino, B., deLahunta, S., McGregor, W., Cusack, R., Owen, A.M., Veldsman, M., Ramponi, C., Barnard, P., 2011. Points in mental space: an interdisciplinary study of imagery in movement creation. Dance Res. 29, 404–432. https://doi.org/10.3366/drs.2011.0026 supplement.
McIlwain, D., Sutton, J., 2014. Yoga from the Mat Up: how words alight on bodies. Educ. Philos. Theor. 46 (6), 655–673. https://doi.org/10.1080/00131857.2013.779216.
Mehling, W.E., Wrubel, J., Daubenmier, J.J., Price, C.J., Kerr, C.E., Silow, T., Gopisetty, V., Stewart, A.L., 2011. Body Awareness: a phenomenological inquiry into the common ground of mind-body therapies. Philos. Ethics Humanit. Med. 6 (6). https://doi.org/10.1186/1747-5341-6-6.
Montero, B., 2016. Thought in Action. Expertise and the Conscious Mind (Oxford UP).
Moran, A.P., Guillot, A., MacIntyre, T., Collet, C., 2012. Re-imagining motor imagery: building bridges between cognitive neuroscience and sport psychology. Br. J. Psychol. 103 (2), 224–247. https://doi.org/10.1111/j.2044-8295.2011.02068.x.
Munroe, K.J., Giacobbi, P.R., Hall, C., Weinberg, R., 2000. The four ws of imagery use: where, when, why, and what. Sport Psychol. 14 (2), 119–137. https://doi.org/10.1123/tsp.14.2.119.
Neemeh, Z.A., Kronsted, C., Kugele, S., Franklin, S., 2021. Body schema in autonomous agents. J. Artif. Intell. Conscious 8 (1), 113–145. https://doi.org/10.1142/S2705078521500065.
Nordin, S.M., Cumming, J., 2005. Professional dancers describe their imagery: where, when, what, why, and how. Sport Psychol. 19 (4), 395–416. https://doi.org/10.1123/tsp.19.4.395.
Nyberg, G., 2015. Developing a 'somatic velocimeter' – the practical knowledge of freeskiers. Qual. Res. Sport Exerc. Health 7 (1), 109–124. https://doi.org/10.1080/2159676X.2013.857709.
Oakley, T., 2009. From Attention to Meaning: Explorations in Semiotics, Linguistics, and Rhetoric (Peter Lang).

O'Shea, H., Moran, A., 2017. Does motor simulation theory explain the cognitive mechanisms underlying motor imagery? A critical review. Front. Hum. Neurosci. 11, 72. https://doi.org/10.3389/fnhum.2017.00072.
Parnafes, O., 2012. Developing explanations and developing understanding: students explain the phases of the moon using visual representations. Cognit. InStruct. 30 (4), 359–403. https://doi.org/10.1080/07370008.2012.716885.
Pascual-Leone, A., Dang, N., Cohen, L.G., Brasil-Neto, J.P., Cammarota, A., Hallett, M., 1995. Modulation of muscle responses evoked by transcranial magnetic stimulation during the acquisition of new fine motor skills. J. Neurophysiol. 74 (3), 1037–1045. https://doi.org/10.1152/jn.1995.74.3.1037.
Pavlik, K., Nordin-Bates, S., 2016. Imagery in dance: a literature review. J. Dance Med. Sci. 20 (2), 51–63. https://doi.org/10.12678/1089-313X.20.2.51.
Petitmengin, C., 2006. Describing one's subjective experience in the second person: an interview method for the science of consciousness. Phenomenol. Cognitive Sci. 5 (3–4), 229–269. https://doi.org/10.1007/s11097-006-9022-2.
Pitron, V., Alsmith, A., de Vignemont, F., 2018. How do the body schema and the body image interact? Conscious. Cognit. 65, 352–358 https://doi.org/10.1016/j.concog.2018.08.007.
Pragglejaz Group, 2007. MIP: a method for identifying metaphorically used words in discourse. Metaphor Symbol 22 (1), 1–39. https://doi.org/10.1080/10926480709336752.
Purser, A., 2018. 'Getting it into the body': understanding skill acquisition through Merleau-Ponty and the embodied practice of dance. Qual. Res. Sport Exerc. Health 10 (3), 318–332. https://doi.org/10.1080/2159676X.2017.1377756.
Ravn, S., 2010. Sensing weight in movement. J. Dance Somat. Pract. 2 (1), 21–34. https://doi.org/10.1386/jdsp.2.1.21_1.
Ravn, S., Christensen, M.K., 2014. Listening to the body? How phenomenological insights can be used to explore a golfer's experience of the physicality of her body. Qual. Res. Sport Exerc. Health 6 (4), 462–477. https://doi.org/10.1080/2159676X.2013.809378.
Ravn, S., Høffding, S., 2017. The promise of 'sporting bodies' in phenomenological thinking – how exceptional cases of practice can contribute to develop foundational phenomenological concepts. Qual. Res. Sport Exerc. Health 9 (1), 56–68. https://doi.org/10.1080/2159676X.2016.1187663.
Rucińska, Z., Fondelli, T., 2022. Enacting metaphors in systemic collaborative therapy. Front. Psychol. 13, 867235. https://doi.org/10.3389/fpsyg.2022.867235.
Rucińska, Z., Gallagher, S., 2021. Making imagination even more embodied: imagination, constraint and epistemic relevance. Synthese 199 (3–4), 8143–8170. https://doi.org/10.1007/s11229-021-03156-x.
Sawyer, K., 2003. Group Creativity. Music, Theater, Collaboration. Erlbaum.
Schneider, S. M. (in prep.). Practices of Body Awareness. Somatic Movement as Interplay between Embodied Experience and Experience of the Body.
Schneider, S.M., Krumnack, U., Kühnberger, K.-U., 2013. Dynamic assembly of figures in visuospatial reasoning. In: Proceedings of the Second Interdisciplinary Workshop The Shape of Things (SHAPES 2013), 1007, pp. 137–141. http://ceur-ws.org/Vol-1007/.
Schwoebel, J., Buxbaum, L.J., Branch Coslett, H., 2004. Representations of the human body in the production and imitation of complex movements. Cogn. Neuropsychol. 21 (2–4), 285–298. https://doi.org/10.1080/02643290342000348.
Sharma, N., Baron, J.-C., 2013. Does motor imagery share neural networks with executed movement: a multivariate fMRI analysis. Front. Hum. Neurosci. 7, 564. https://doi.org/10.3389/fnhum.2013.00564.
Sheets-Johnstone, M., 2007. Kinesthetic memory. Theoria et Historia Scientiarum 7 (1), 69–92. https://doi.org/10.12775/ths.2003.005.
Sheets-Johnstone, M., 2009. Thinking in movement. In: The Corporeal Turn: An Interdisciplinary Reader. Andrews Uk Ltd, pp. 28–63.
Shilling, C., 2017. Body pedagogics: embodiment, cognition and cultural transmission. Sociology 51 (6), 1205–1221. https://doi.org/10.1177/0038038516641868.
Shvarts, A., Bakker, A., 2019. The early history of the scaffolding metaphor: bernstein, Luria, Vygotsky, and before. Mind Cult. Activ. 26 (1), 4–23. https://doi.org/10.1080/10749039.2019.1574306.
Simonsmeier, B.A., Andronie, M., Buecker, S., Frank, C., 2021. The effects of imagery interventions in sports: a meta-analysis. Int. Rev. Sport Exerc. Psychol. 14 (1), 186–207. https://doi.org/10.1080/1750984X.2020.1780627.
Simonsmeier, B.A., Buecker, S., 2017. Interrelations of imagery use, imagery ability, and performance in young athletes. J. Appl. Sport Psychol. 29 (1), 32–43. https://doi.org/10.1080/10413200.2016.1187686.
Sirigu, A., Grafman, J., Bressler, K., Sunderland, T., 1991. Multiple representations contribute to body knowledge processing: evidence from a case of autotopagnosia. Brain 114 (1), 629–642. https://doi.org/10.1093/brain/114.1.629.
Standal, Ø.F., Engelsrud, G., 2013. Researching embodiment in movement contexts: a phenomenological approach. Sport Educ. Soc. 18 (2), 154–166. https://doi.org/10.1080/13573322.2011.608944.
Sutton, J., 2007. Batting, habit and memory: the embodied mind and the nature of skill. Sport Soc. 10 (5), 763–786. https://doi.org/10.1080/17430430701442462.
Sutton, J., McIlwain, D., Christensen, W., Geeves, A., 2011. Applying intelligence to the reflexes: embodied skills and habits between Dreyfus and Descartes. J. Br. Soc. Phenomenol. 42 (1), 78–103.
Sweigard, L.E., 1974. Human Movement Potential: Its Ideokinetic Facilitation. Harper & Row.
Tay, D., 2017. Exploring the metaphor–body–psychotherapy relationship. Metap. Symb. 32 (3), 178–191. https://doi.org/10.1080/10926488.2017.1338021.
Todd, M.E., 1968. The thinking body: a study of the balancing forces of dynamic man (Unabridged republication of the orig. ed. first publ. in 1937).
Toner, J., Jones, L., Moran, A., 2016a. Bodily crises in skilled performance: considering the need for artistic habits. Perform. Enhanc. Health 4 (1–2), 50–57. https://doi.org/10.1016/j.peh.2015.10.001.
Toner, J., Montero, B.G., Moran, A., 2016b. Reflective and prereflective bodily awareness in skilled action. Psychol. Conscious.: Theory Res. Pract. 3 (4), 303–315. https://doi.org/10.1037/cns0000090.
Toner, J., Moran, A., 2014. In praise of conscious awareness: a new framework for the investigation of "continuous improvement" in expert athletes. Front. Psychol. 5 (769), 1–5.
Toner, J., Moran, A., 2015. Enhancing performance proficiency at the expert level: considering the role of 'somaesthetic awareness.'. Psychol. Sport Exerc. 16, 110–117 https://doi.org/10.1016/j.psychsport.2014.07.006.
Tufnell, M., Crickmay, C., 2006. Body Space Image: Notes Towards Improvisation and Performance (Repr). Dance Books.
Turner, M., 1994. Reading minds: The study of English in the age of cognitive science. Princeton Univ. Press.
Underman, K., 2022. The social transmission of bodily knowledge. Body Soc. 28 (3), 30–62. https://doi.org/10.1177/1357034X221103944.
Varela, F.J., Thompson, E., Rosch, E., 1991. The Embodied Mind: Cognitive Science and Human Experience. MIT Press.
Walsh, M., 2021. The Body in Coaching and Training an Introduction to Embodied Facilitation. Open University Press.
Wayne, P., Fuerst, M., 2013. The Harvard Medical School Guide to Tai Chi: 12 Weeks to a Healthy Body, Strong Heart, and Sharp Mind. Shambhala.
Weichold, M., Rucińska, Z., 2021. Pretense as alternative sense-making: a praxeological enactivist account. Phenomenol. Cognitive Sci.. https://doi.org/10.1007/s11097-021-09770-x.
Zwaan, R.A., 2004. The immersed experiencer: toward an embodied theory of language comprehension. Psychol. Learn. Motiv. 44, 35–62.