The nature and difficulty of physical efforts

Olivier Massin[1]

Abstract

We make physical efforts when we swim, carry shopping bags, push heavy doors, or cycle up hills. A growing concern among philosophers and scientists in related fields is the absence of a well-defined concept for physical efforts. This paper addresses this issue by presenting a force-based definition of physical efforts. In Sect. 1, we explore the shortcomings of existing definitions of effort. Section 2 introduces the force-based account of efforts according to which making an effort consists in exerting a force so as to make an object move or stay at rest. Section 3 introduces three central distinctions stemming from the account: failed vs. successful efforts; resisted vs. unresisted efforts; and efforts vs. effortful actions. Section 4 presents a key objection, to the effect that the force-based theory cannot account for the difficulty of efforts: efforts usually feel difficult, but effort's difficulty is not always a function of the magnitude of force(s) exerted. Section 5 argues that the most in-depth account of difficulty so far, that developed by Bradford (2015), cannot account for the difficulty of efforts. Sections 6 & 7 develop a novel account of effort's difficulty.

1 Problems with existing definitions

Contemporary research on efforts is as prolific as it is scattered. A growing concern is that a common definition of efforts is lacking, which impedes the integration of various research areas (see e.g., Richter & Wright, 2014; Westbrook & Braver, 2015; Pageaux, 2016; Von Kriegstein, 2017; Massin, 2017a; Steele, 2020; Bergevin & al., 2023; Bermúdez & Massin, 2023). One possible reaction to that recurring complaint is to embrace pluralism concerning efforts and assert that individuals employing the term 'effort' across different disciplines are, in fact, referring to distinct phenomena

✉ Olivier Massin
olivier.massin@unine.ch

1   Institute of Philosophy, University of Neuchatel, Neuchâtel CH 2000, Switzerland

in order to address distinct problems. In contrast, I advocate for monism regarding effort: all efforts have a common nature; all belong to a same kind. A single definition of effort is not only needed, it is achievable. I shall not defend that strong view here, but only a weaker one: *physical* efforts can be defined. That is, physical efforts have a common and proper nature, which can be spelled out.

Physical efforts (Julie's effort to lift a weight) are just one species of effort among many others: there are also mental efforts (Paul's effort to stay focused on homework), economical efforts (Mary's financial effort to save her company), social efforts (Bob's effort to convince Julie), institutional efforts (the university's effort to attract more good students), etc. Physical efforts, however, are paradigmatic cases of effort. Yet, even a shared definition of *physical* efforts is lacking. Research on physical effort either leaves effort undefined – relying on some tacit understanding of it to investigate its underpinnings, causes, effects, or functions – or introduce definitions which turn out to be wanting. Let us consider four of these.

In exercise physiology, effort is sometimes equated with physical exercise or activity. Physical activity is in turn standardly defined as 'any bodily movement produced by skeletal muscles that results in energy expenditure.' (Caspersen et al., 1985). We get the following definition:

Definition 1: physical effort=df bodily movement caused by muscle activity and resulting in energy expenditure.

Such a definition raises several worries. First, some motions caused by muscles are not physical efforts. Consider the movement of your limb due to a spontaneous contraction of your muscle, to a reflex hammer, or to some electrical stimulation of your muscle. Such bodily movements are caused by skeletal muscles and results in energy expenditure but are arguably not efforts. This is because physical efforts have a teleological aspect that such definitions leave out. Efforts are made *in order to* reach some goal. Second, the proposed definition leaves no room for effort failures. If muscle activity fails to bring about bodily movement, we cannot say that our effort has failed on this definition, we must say that we made no effort. This defect arguably follows from the previous one. Had goal directedness been included in the definition, it would have been possible to maintain that failed efforts are muscle-caused bodily movements that do not attain their goal. Third, not all efforts result in motions. Suppose Julie makes an effort to raise her tied hand. According to the definition, Julie makes no effort, since her muscle activity results in no movement. Fourth, this definition entails that only creatures having muscles can make effort. This is an unnecessarily strong restriction. Muscle contractions are not the only way for creatures to move. Some robots and prothesis use pneumatic systems or motors. Furthermore, some animals are able of motion while lacking muscles: for example, placozoa are able of locomotion without using muscles (Ruthmann et al., 1986), and sea sponges are able to contract while lacking muscles (Nickel et al., 2011). A definition of effort should not rule out the possibility that such creatures make efforts. In sum, defining physical efforts in terms of muscle contraction bringing about motion ignores the teleological aspect of efforts and therefore the possibility of effort failure, forbids static efforts and excludes some anatomical realizations of effort.

Perhaps because of such limitations, a recent paper in exercise physiology alternatively defines effort thus: '[physical] *Effort* is thought as the level of cortical activity associated with the initiation or maintenance of a behaviour.' (Cheval & Boisgontier, 2021).

Definition 2: physical effort=df level of cortical activity associated with causing behaviour

This definition has the advantage of ruling out behaviours caused by externally generated muscle activity that were raised as counterexamples to definition 1. However, the teleological aspect of effort is still missing, as is seen in the fact that the distinction between effort failure and effort success is hard to draw within this definition. Thus, an intense cortical activity not causing any behaviour does not count as a failed effort on that proposal, but as a non-effort. Second, equating effort with a *level* of activity is confused: an effort is not a level. If anything, it should be the *level* of effort —e.g. the effort's intensity— that is equated to a level of brain activity. Third, 'association' being a loose relation and the cerebral cortex being involved in many sensorimotor functions, the definition leads to effort overcounting. We do not want, for instance, to equate (the level of) physical effort with the level of visual or proprioceptive cortical activity causing a behaviour. If a small motion of one's index follows from an intense level of activity in the visual cortex, surely no intense *physical* effort has been performed. Lastly, this definition implies that any creature without a cortex is incapable of making an effort. It entails, for example, that robots or living beings lacking a cerebral cortex—such as cephalopods or fishes—would be unable to engage in efforts. One might prefer a definition of effort that doesn't preclude such scenarios, allowing for a broader range of physical realizations of efforts.

A third kind of definition often found in dictionaries is this:

Definition 3: physical effort=df strenuous physical exertion to achieve something.

Such a definition, I believe, is extensionally adequate. It is, however, covertly circular. For how are we to understand 'strenuous' without appealing to effort? The Oxford dictionary defines efforts as 'Strenuous physical or mental exertion' and 'strenuous' as 'needing great effort and energy'. Indeed, strenuousness is often characterized as a negative feeling that qualifies some action. But actions may also be painful, boring or disagreeable (see Pageaux, 2016 for discussion). What then distinguishes the painfulness or discomfort of some action from its strenuousness? An initially promising line of answer is that strenuousness, contrary to painfulness or discomfort, essentially accrue to actions that involve efforts. But such an answer would render the account overtly circular (similar worries undermine the idea of defining effort in terms of difficult actions, as we shall see in more detail).

Bermúdez (forthcoming) develops a feeling-based account of efforts which is an important refinement of the present definition. An effort, Bermúdez maintains, is an action that is accompanied by a feeling of effort. One immediate cost of this proposal is that a characterization of the feeling of effort must be given prior and independently to an account effort, on pain of circularity. Feelings of effort, in particular, cannot be

defined in terms of feelings that represent efforts, which is prima facie surprising. Bermúdez is aware of this and develops a cost-based account of the feelings of effort meant to circumvent that difficulty which deserves a more detailed examination that can be given here (see Bermúdez & Massin, 2023 for discussion). The disagreement between Bermúdez's feeling-based account and the force-based account defended here is to some extent verbal: there clearly are force exertions as there clearly are actions that feel effortful, and they only partly overlap. Which of these deserve to be called "effort" should be decided on linguistic grounds. One consideration in favour of the force-based theory here goes as follows. Take the scenario of someone lifting a small weight over a period, such that the effort sensation arises only after a certain duration. According to the feeling-based theory, this person initiates her effort only when she begins to sense something, implying that her effort commences after the lifting has started. A more intuitive description, aligning with the force-based theory, is that her effort begins precisely when she initiates lifting the weight. What happens after a while is only that she starts feeling the effort she is exerting. If reflections of this nature hold merit, the force-based account more accurately encapsulates what we commonly refer to as 'effort'.

   Physical effort is, fourth and finally, often defined in terms of resource allocation: "The construct of effort can be defined as the mobilization of resource to carry out behaviour", write Gendolla & Wright, 2009, p. 134; see also Wright, 2016; Richter et al., 2016; von Kriegstein, 2017; Szwed et al., 2021. In the case of physical effort, the resource is standardly equated to (physical) energy:

Definition 4: physical effort=df expenditure of physical energy in order to achieve some goal

This definition is, I think, extensionally adequate and non-circular. It can actually be shown to be equivalent to the force-based definition of effort to be defended below, according to which physical efforts are exertions of physical forces in order to bring about some kinematic change. To illustrate, on the force-based view, the effort to open a jar of jam consists in exerting a physical force on its lid in order to make it rotate. The reason why force-based and energy-based definitions of effort are extensionally equivalent is that force-based and energy-based classical mechanics are themselves, as Feynman (1963) puts it "exactly equivalent" (see Massin, 2009 for discussion). There are, however, three reasons to prefer the force-based account of effort to the energy-based one. The first is that the force-based account is closer to our ordinary conception of physical effort. It is not just the etymology of the term "effort" which refers to force (the term derives from the old French word "esforz", which means exerting force); there is also a large array of expressions connected to effort which are standardly defined in terms of force exertion rather than in terms of energy expenditure: pushing, pulling, pressing, squeezing, compressing, gripping, stretching…The second reason to consider the force-based approach more fundamental than the energy-based one is that, as we shall see, it better captures the double-sidedness of efforts, which usually involve both a force exerted by the agent, and a resistive force exerted by the physical world on which the agent acts. The idea of resistance to one's effort, on the other hand, is not straightforwardly captured by the energy-based

theory, which tends to view effort as a one-sided action, where the agent unilaterally expends amounts energy without any essential contribution by the outside world. The third reason to favor the force-based account of effort over the energy-based account is that the force-based account more easily explains how effort can be felt. If efforts are goal-directed force exertions, part of the feeling of effort is going to involve the feeling of exerted forces. As it happens, we are well equipped to perceive forces through our muscles, tendons and skin. Studies on the physiology and psychology on force-perception go back to the early works of Weber (1905). Empirical investigation into the perception of forces —be that through cutaneous receptors, muscular receptors, or both together with a general haptic system— has never ceased since then (see e.g. Turvey & Carello, 1995; Robles-De-La-Torre & Hayward, 2001; Lederman & Klatzky, 2009), and has recently been the object of renewed interest in the context of research about virtual and augmented reality (e.g., Robles-De-La-Torre, 2008; Biswas & Visell, 2021). In philosophy, despite influential skeptical worries about the perception of forces originating in Hume, the perception of forces has been more recently defended by Sanford (1976); Perkins (1983, 242 sqq.), Fales (1990, 16), Armstrong (1993, 97−9;1997, 213), Wilson (2009), Schrenk (2014); Marshall (2015); de Vignemont and Massin (2015). The perception of physical energy, on the other hand, remains comparatively poorly understood. While we have mechanoreceptors dedicated to the perception of pressures and tensions in our skins, tendons and muscles, no receptors dedicated to the perception of energy, or energy transfers, have been found so far. Likewise in mechanics, there is no way to directly measure energy, while we have scales and other dynamometers to measure forces (Massin, 2017b). Consequently, upholders of the energy-based account often appeal to the measurement of exerted forces to infer the amount of energy expended (Richter, 2015; Richter et al., 2016). Besides, the perception of (a lack of) energy, when studied, is typically equated with the feeling of fatigue (though the claim is challenged by Loy & al. 2018) rather than with the feeling of effort. As a result, the energy-based account of effort is in a trickier position than the force-based account when it comes to explaining the feeling or experience of effort. This does not mean that the energy-based account of effort is to be rejected: in view of the above-mentioned equivalence between the force-based and the energy-based mechanics, the energy-based account of effort is extensionally adequate and may be instrumentally more relevant in some contexts of investigation. The claim is, however, that the force-based account is more fundamental in the sense that it captures the real nature of efforts. We can usefully think of efforts in terms of energy expenditures, but what effort really are, are force exertions.

Faced with this plethora of definitions of physical efforts (see Massin, 2017a; Steele, 2020; Bermúdez & Massin, 2023 for discussions of further definitions), it could be argued that what is needed is not really a shared definition of physical efforts —some pre-theoretical understanding of physical efforts could be enough— but that all we need to agree to is the *measurement* of physical efforts. There is however little agreement on how to measure effort, suggesting a deeper disagreement on the nature of effort itself. One first common procedure is to rely on grip force, measured via handgrip dynamometers. Within that first paradigm, one finds already at least two ways of measuring the intensity efforts. Some equate the intensity of effort with the

magnitude of the force exerted (Zénon et al., 2014; Demanet et al., 2013), while others use the ratio of the exerted force by the maximum (intentionally) exercisable force (Kurniawan et al., 2010; Schmidt et al., 2012). Another influential approach to measure effort in exercise sciences is to rely on the anaerobic threshold, usually defined as the highest intensity of exercise that can be sustained by the aerobic metabolism only. Both the definition and the measurement (e.g., by ventilatory expired gas analysis) of that threshold is, however, a matter of a longstanding and ongoing controversy (see Svedahl & MacIntosh, 2003; Poole & al., 2021; MacIntosh & al., 2021, for useful discussions). Yet another measurement appeals to the percentage of the individual maximal heart rate (Arena et al., 2016). On top of these objective measurements, effort is often measured through subjective reports, following the groundbreaking work by Borg (1962)–see Pageaux (2016) for precious discussion.

Do all those measures target the same thing – the level of effort? Or could it be that they track different aspects of effort? For instance, it could be (i) that the measure of the grip force targets the *intensity* of the effort; (ii) that the measurement of the ratio of that force per the maximally exercisable force targets the *difficulty* of the effort; (iii) that anaerobic thresholds like measurements measure the *capacity* to sustain the effort; (iv) that subjective reports target the *feeling* of effort? To answer these questions, we need to be able to draw such distinctions between the intensity, the difficulty, the capacity, and the feeling of efforts. To do this, a pre-theoretical understanding of effort is not enough. An explicit definition is needed, to which I now turn.

2 The force-based theory of physical efforts

I shall assume that the verb phrases *striving to* and *making an effort to* are synonymous and are our best linguistic starting points to elucidate efforts.[1] Taking those expressions seriously teaches us two things about efforts. Firstly, efforts are actions: striving, as well as making an effort, are things we do, by contrast to things that happens to us. They can figure in the content of action-directed attitudes and norms. One can intend, decide or promise to make an effort, one can be praised, blamed or feel guilty for having failed to make an effort (or for having made an effort), one can be under an obligation or interdiction to strive to do something, etc. Secondly, efforts are purposive actions, actions we do in order to perform other changes: making an effort entails aiming at causing a certain change beyond the effort itself: that towards which one strives. It is indeed crucial to distinguish the action that the effort consists in, from the change that the effort aims at. If Julie pulls the cork in order to open the bottle, opening the bottle is the change she aims at bringing about, and pulling the cork is the effort she does in order to bring about that change. So, under the assumption that *striving to* and *making an effort to* are good linguistic guides to the nature of efforts, efforts are actions that aim at bringing about some changes.

---

[1] I do not assume, though, that *trying* is synonymous with *striving*: while effortless tryings (e.g., to try to refresh the room by letting the window open) are conceivable, effortless strivings make little sense. As Waismann noticed:'To try' seems to mean less than 'to make an effort'; there is no reference to any energy in 'trying', unlike what is conveyed by the word 'effort'. (Waismann, 1994, 72). This suggests that all efforts are tryings, but not the reverse. See also note 5 below.

Not all efforts are physical: we also make efforts to convince people, to resist temptations, to understand obscure texts, to solve problems, to remember a name, etc. Paradigmatic cases of *physical* efforts — also called motor or muscular efforts — include swimming, rowing, lifting pumpkins, arm wrestling, pushing heavy doors, removing weeds, cycling up hills, climbing stairs, carrying shopping bags, pressing oranges, tightening a screw or bending a bow. Let us start by focusing on the effort of lifting a heavy body. To lift a body, we need to exert a force on it greater than the gravitational force acting on it (that force being its weight). This suggests the following definition of physical efforts:

force-based theory of physical efforts: to make a physical effort to move a body is to exert a force on it, directly or indirectly, in order to make it accelerate or stay at rest, this force being either not counteracted or partly or fully counteracted by an opposite force – the 'resistive force'.[2]

Let me explain in turn the various terms used in this definition.

Forces. I assume a realist conception of Newtonian forces, which are taken to exist mind-independently and irreducibly. By irreducibility it is meant here that forces cannot be reduced to changes in spatio-temporal relations between macroscopic bodies. In particular, forces cannot be reduced to body accelerations (see Wilson, 2007; Massin, 2009); rather, forces cause, under some conditions, accelerations of the bodies they act on. Forces are thus understood, in line with classical mechanics, as physical relations between bodies (or parts thereof), that causally explain the changes in bodily motions (or the lack of such changes). In that sense, forces are dynamical entities: non-kinematic entities that causally explain the kinematical behaviour of the bodies they act on. Potential energy is another dynamical entity. The key difference between energy and forces is that forces are vectorial properties, in the sense that they have not only a magnitude, but also a direction.

Direct vs. indirect force exertions. Some forces in nature are exerted directly, some are exerted only indirectly. When we break bread with our hands, we directly exert a force on the bread. When we cut a piece of bread by using a knife, we indirectly exert a force on the bread, through the knife. How forces are transmitted through different materials and shapes constitutes an important part of continuum mechanics (on the transmission of forces in rigid bodies, see e.g. Gross et al., 2009: 9 sqq.; Hibbeler, 2003: 124 sqq.; Meriam and Kraige, 1998: 24 sqq.). It is here assumed, correspondingly, that forces can be transmitted through various media, and therefore can be indirectly exerted. That assumption is needed as restricting the definition to direct exertions of forces would leave aside a wide variety of physical efforts. A case in point is the effort of climbing stairs. In such as a case, although we directly exert a force on the stairs, we are not trying to move the stairs. Instead, we use it as a prop for our own motion (Fricke & Snowdon, 2003). Including indirect exertions in the

---

[2] The force-based account of efforts is not unprecedented. Psychologists and philosophers such as Tracy, Dilthey, Maine de Biran, Peirce and Scheler argue that the feeling of resistance to our effort discloses the distinction between ourselves and the external world (see Massin, 2017a, 2022). The force-based theory is also presupposed in experimental paradigms which rely on the measurement of exerted force (Zénon et al., 2014; Demanet et al., 2013) or on the ratio of exerted force by the maximum force (Kurniawan et al., 2010; Schmidt et al., 2012) to define the intensity of effort. Versions of the force-based theories are also adopted in Kruglanski & al. (2012); Lhuillier & al. (2018).

definition allows us to say that when we climb stairs, we indirectly exert a force on our body – by exerting a force on the stairs – in order to move our body.

Counteraction of forces. The definition mentions counteracted and un-counteracted forces. Let me first introduce these notions before motivating the need for them (see. Figure 1):

- *Un-counteracted force.* Consider the simple case of a single, and therefore un-counteracted force acting on a body (e.g., free fall). In such a case, the force *causes* the acceleration of the body it acts on in inverse proportion of its mass, in accordance with Newton's second law.
- *Counteracting forces.* Counteracting forces are a special case of *several* forces acting on a same body: it corresponds to the cases where forces that act on a same body have *opposite directions* as when one presses a stone between one's hands. 'Counteracting' should be understood in terms *of mutual preventive causation* (Massin, 2017b): counteracting forces prevent each other from causing the acceleration of the body each would have caused; had they been acting alone. There are two cases of counteracting forces important for the definition of effort.

  - *Fully counteracting forces.* When two counteracting forces have the same magnitude, *they fully* counteract each other. In such a case, no acceleration is caused.
  - *Partly counteracting forces.* When two forces of *different intensities* and *opposite directions* act on the same body, the stronger force is *partly* counteracted by the smaller one. That is, the smaller force prevents only a sub-part of the stronger one to cause the acceleration it would have caused, had it acted alone. The other, un-counteracted part of the stronger force brings about an

Un-counteracted force: F_1 causes the body to accelerate.
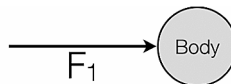
Fully counteracting forces: F_1 & F_2 prevent each other from causing the body to accelerate.
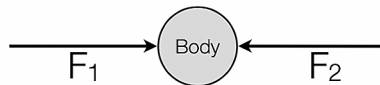
Partly counteracting forces: F_1 and a sub-part of F_2 prevent each other from causing the body to accelerate. The un-counteracted part of F_2 causes the body to accelerate.
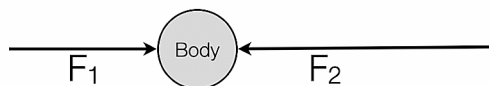
Fig. 1 Counteracting forces

acceleration of the body (see Massin, 2017b for a defense of this account of the composition of forces, called "residualism" since it equates resultant forces with the component forces that are left un-counteracted).

Summing up: forces, when un-counteracted, cause accelerations; forces when fully counteracted, cause no acceleration, but prevent each other from causing acceleration; forces that are being partly counteracted prevent the counteracting force from causing an acceleration and, for what is left of them, cause an acceleration.

In order to. Forces are physical relations and exerting a force is not essentially a psychological, intentional episode: nature is replete with forces, and most of those forces are exerted by bodies deprived of goals or intention. Without creatures having goals, the world would abound with forces, but lack efforts. Efforts are essentially teleological: making an effort entails aiming at something. This means that efforts, quite like the action of intentionally raising one's arm, are episodes which are partly psychological and partly physical. The force exerted during an effort constitutes its purely physical component, akin to the motion of the arm in the intentional act of raising it. On the other hand, the intention underlying an effort forms its purely psychological component, analogous to the intent to elevate one's arm. On the whole, physical efforts intertwine both the physical and psychological realms: they are psycho-physical episodes.

We make efforts or strive *to* reach some end. In the case of physical effort, the end is kinematical: we aim at changing the motion of an object or maintaining it at rest. Can't we aim at exerting forces, simpliciter? Can't we make efforts for their own sake? In some admittedly rare situations, our final goal is to exert a force (e.g., playing with a dynamometer and trying to reach the highest exerted force). Even in such cases, I submit, we must aim, as an intermediary goal, at moving our bodies in a direction (or at maintaining it at rest). All physical efforts, I propose, have kinematical goals, though such goals are usually instrumental goals meant to achieve other goals, which include, in some peculiar cases, the goal of exerting forces.

That all physical efforts are made with the intention of reaching a kinematical goal may lead one to claim that all physical efforts are intentional. We should, however, beware of the following ambiguity: on the force-based account, efforts are intentional in the sense that when we make an effort, we aim at some motion (or rest). But efforts are not necessarily intentional in the sense of being themselves intended (whether this is the case is left open by the account). In other words, when we make an effort, we must intend to move or stay at rest, but we need not intend to make an effort.

Resistive force. Such goal-directedness allows us to introduce the notion of a resistive force. The resistive force is the force counteracting, partly or fully, to the one exerted by the agent in order to fulfil his goals. The resistive force is not exerted by the agent (special cases apart, as when we press our hands against each other), but it is resistive in virtue of opposing the force purposefully exerted by the agent. Consequently, in a world deprived of goal-oriented creatures, there would be no resistive force in the present sense. A difficult issue is whether inertia can count as a resistive force. For the purpose of a theory of physical effort, counting inertia as a force against which we sometimes struggle proves quite useful. Thus, contracting our abdominals

when the train brakes to avoid leaning forward, we are resisting the inertia of the top of our body.[3]

Wrapping up, the force-based theory equates efforts with actions of a certain kind, namely the actions of exerting a force in order to affect the motion of some body. It should be noted that in this picture forces are causal relata and not instances of causation. Forces cause two things: they cause accelerations when un-counteracted, and they cause other forces not to cause accelerations when counteracted. Forces are caused by two kinds of substances in that picture, namely the agent who exerts the force and, for the resistive force, by the body on which the agent acts. See Fig. 2.

3 Three distinctions

Based on the force-based definition of physical efforts, three useful distinctions can be introduced.
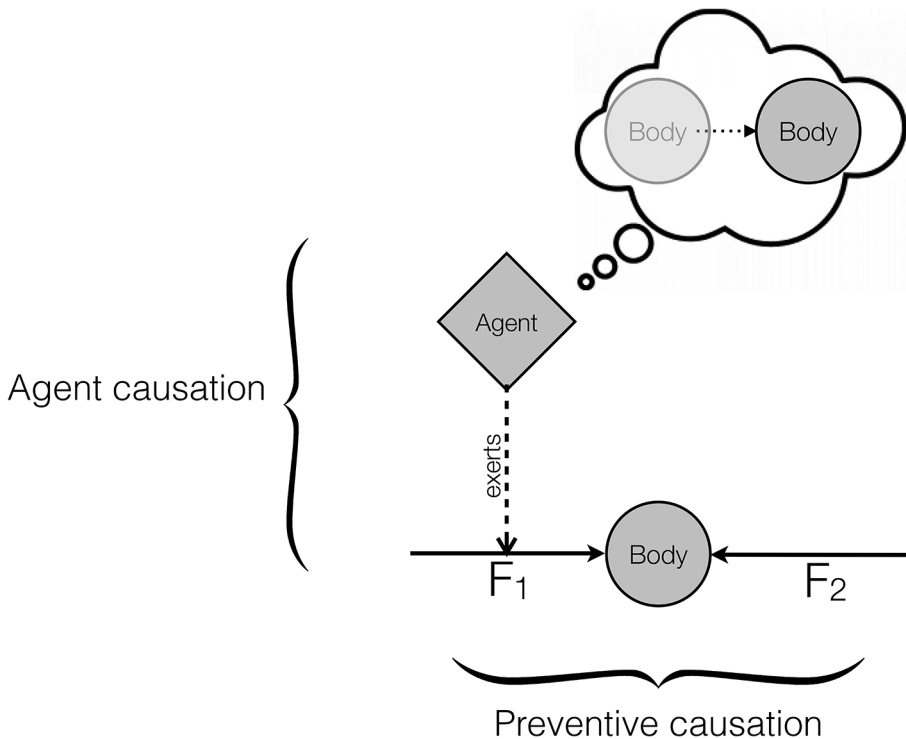

Fig. 2 The force-based account of effort

---

[3] This is not to claim that the fictitious force —sometimes misleadingly called inertial force— which explains our motion relative to the train is real. Realism about the force of inertia does not entail realism about so-called pseudo-, fictitious or inertial- forces, that is forces that seem to act on bodies inside non-inertial frames of reference. Quite the contrary: inertia explains why some fictious forces appear. When the train accelerates, the passengers get the impression that a force is pushing them backwards within the train. This backward force is a fictitious force, explained by a real force: the passenger's inertia.

1. Success vs. failure. The success conditions of effort can be defined in the following way:

Effort-success: A physical effort succeeds when its goal gets realized as an effect of the exerted force.

Effort-failure: An effort fails when it does not succeed (that is, when its goal does not get realized or when its goal gets realized but not as an effect of the exerted force).

That is, an effort fails if its goal is not realized or if its goal is realized but not in virtue of the force exerted by the agent. If Bob pushes the door to open it and the door stays closed, Bob's effort fails. If Bob pushes the door and the door opens automatically because some detector reacts to Bob's presence, Bob's effort fails as well. If Bob pushes the door, and the force he exerts in doing so causes the door to open, his effort succeeds.

2. Resisted vs. unresisted efforts. The definition of efforts entails that some efforts encounter some resistance, while others do not. We therefore have two kinds of efforts:

Unresisted efforts: efforts whose exerted force meets no counteracting force.

Resisted efforts efforts whose exerted force is at least partly counteracted by some other force(s).

Resisted efforts come in two kinds, depending on whether the exerted force is fully or only partly counteracted. It would be a mistake to think that successful efforts cannot be fully counteracted. When Mary presses on some chandelier from below to prevent it from falling, the force she exerts may be fully counteracted by the chandelier's weight and yet her effort succeeds as long as the chandelier does not fall thanks to her pressure. Likewise, partly resisted effort may fail. If Mary's goal is to maintain the chandelier in its place and she exerts too strong a force on it resulting in the chandelier moving upward across the ceiling, her effort fails despite being only partly counteracted by gravitation. Fully resisted efforts are static cases where no motion is produced. Physiologically, they correspond to isometric muscle contractions (by contrast to dynamic muscle contractions), that is, to cases where muscles contract but neither shorten nor lengthen.

Why grant that some efforts are unresisted? Why not require that all efforts encounter some resistance? Although prima facie plausible, that proposal faces an important difficulty. If we refuse to count unresisted efforts as efforts, we should, by parity, also refuse to count partly resisted effort as efforts. This is because any partly resisted effort can be decomposed into a fully resisted effort and an unresisted one. This in turn follows from the fact that under the present approach, partly counteracted forces can be decomposed into two forces: one fully counteracted force, and one un-counteracted force. Thus, rejecting unresisted efforts amounts to saying that *all efforts are fully resisted*: a partially resisted effort would in fact consist of a fully resisted effort *plus* an exertion of un-counteracted force, which is not an effort. This

sounds very odd. This entails, for instance, that efforts can never cause accelerations, and therefore that all efforts to move an object are doomed to fail. So, either we deny that partly resisted efforts can be analyzed into two sub-efforts: a fully resisted effort (the force exerted to overcome the object's resistance) and a fully unresisted force exertion (the surplus force exerted to bring about the acceleration); or we accept unresisted efforts. The first option contradicts the residualist picture of the composition of forces introduced above. We should therefore accept unresisted efforts.

Note, however, that one can accept unresisted efforts while rejecting *pure* unresisted efforts, understood as unresisted efforts which are not components of a larger partly resisted effort. On that view, though there are unresisted efforts, each such effort necessarily occurs together with a fully resisted effort. One reason to believe that pure unresisted efforts are impossible is that in reality, every force necessarily encounters some resistance. Descartes *(Principles*, II, iv) considers a world where 'all the bodies recede as quickly as our hands approached'. In such a world, bodies oppose no resistance but flee away as soon as we touch them. But whether such a world is metaphysically possible is controversial.[4] A reason to believe that all forces encounter some counteracting force (and therefore that all efforts are counteracted) is to maintain, as I suggest above, that inertia is a force. If so, then even when no external force acts on a body, as in Descartes' world, any force exerted on that body will nevertheless be at least partly counteracted by that 'power of resisting by which every body, as much as in it lies, endeavors to persevere in its present state, whether it be of rest or of moving uniformly forward in a right line.' (Newton, 1999).

3. Efforts vs. effortful actions. The force-based theory equates effort with a kind of purposive action: actions which we perform in order to bring about a certain consequence.[5] But bringing about that consequence is, sometimes at least, also an action. Thus, when Julie successfully pushes the door to open it, she also opens the door. The relation between pushing the door to open it – the effort – and opening the door is a relation between a basic and a less basic action: Julie opens the door by pushing it.[6] The pushing of the door is an effort; what about the opening of the door? If one maintains that the opening of the door is a distinct action from the pushing of it, one should deny that the opening is an effort for it is not identical with an exertion of force. I propose to say that the opening, although not an effort, is an *effortful action*, an action done by means of making an effort.

---

[4] Newton's Third Law is sometimes invoked to support the idea that all forces are counteracted, but that is a mistake: action and reaction are forces exerted on different bodies. If a exerts a force on b, then b exerts an equal and opposite force on a. Reaction and action are not counteracting forces for they do not act on the same (part of) body. The law of inertia is a better reason to believe that all forces are at least partly counteracted.

[5] If tryings are defined as purposive actions, as per Taylor (1973: 79; Cleveland, 2016, Chap. 6; Massin, 2014; see Ruben, 2018, Chap. 2 for critics.) then efforts are a species of tryings.

[6] The proper way of drawing the distinction between basic and non-basic actions, as well as the validity of the distinction itself continues to be a subject of significant controversy. I assume here that certain actions are less basic than others, without making additional assumptions about whether some actions are ultimately basic or whether basic actions are confined to a specific category.

Effortful action: action which is not an effort, but which is made by means of making an effort.

What if one subscribes to Davidson (1971)'s identity thesis – the view that when an agent *F*s by *G*-ing, his *F*-ing is identical to his *G*-ing? In that case, the opening of the door is identical to the pushing of the door, and is therefore an effort. One may, however, relocate the distinction between efforts and effortful actions at the level of actions descriptions: the action at stake is an effort under the description of 'pushing the door', but it is not an effort – but an effortful action – under the description of 'opening the door'.

The distinction between effort and effortful action allows to make sense of recurrent adverbialist intuitions about effort. It is tempting indeed to think of effort not as a particular kind of action, but rather as a way of performing an action, namely, *effortfully*. On the present proposal, "effortfully" indeed captures a way to perform an action, but that adverbial modification is not taken to be primitive or undefinable. On the contrary, to perform an action effortfully is to perform that action by means of making some efforts.

4 The difficulty objection

That efforts are *difficult* is often thought to be an essential feature of them. 'Effort is only effort when it begins to hurt' writes Ortega y Gasset (1968). The problem is that the force-based account, or so it seems, does not allow us to account for the difficulty of efforts.

Difficulty objection: the force-based theory cannot account for the difficulty of effort, which is an essential feature of them.

Why can't the force-based theory straightforwardly account for difficulty? The force-based account allows distinguishing two gradable properties of efforts:

Magnitude of efforts: the magnitude of an effort is equal to the absolute magnitude of the exerted force.

Intensity of efforts: the intensity of an effort is equal to the magnitude of the part of the exerted force which is fully counteracted.[7]

To illustrate this, consider the three following efforts. All have the same magnitude, but they have decreasing intensity, the third one, being an unresisted effort, having no intensity:

---

[7] Some people also speak of the *strength* of effort, but I prefer to reserve "strength" to agents. An agent's strength, arguably, consists in his capacity to make efforts. The more intense her efforts, the stronger he is.
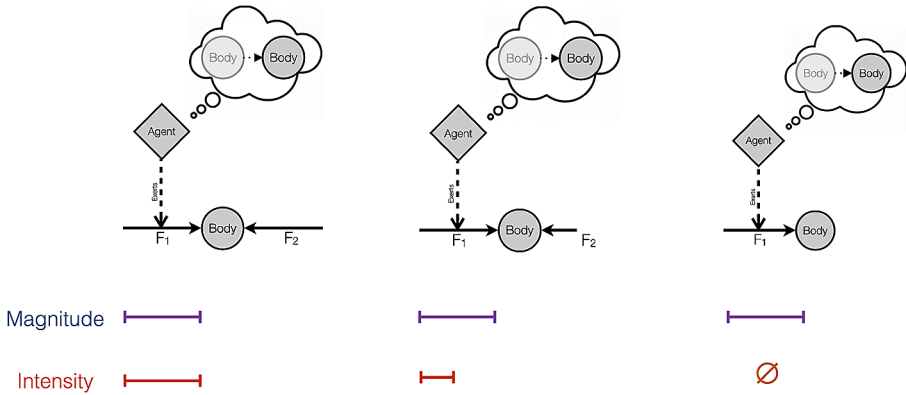
Both magnitude and intensity are scalar quantities that characterize efforts. In case of a fully resisted effort, the intensity of the effort is equal to its magnitude, but intensity and magnitude do not systematically co-vary. In case of a partly resisted effort, the intensity of the effort is inferior to its magnitude. Suppose Bob's lock is seized, as a result of which Bob has developed the habit of exerting an intense rotational force to open it. One day Maria unseizes it without telling him. Bob exerts the same intense force when he comes back, and to his surprise, the lock opens smoothly and very quickly. Bob's efforts before and after Mary's repair have the same magnitude (for Bob applies the same force in all cases) but his last effort has a lesser intensity (for the resistance met is lower). Likewise in the case of unresisted efforts, the intensity of the effort is null, contrary to their magnitude. Consider again Descartes's world where bodies recede without any resistance when our hands approach (assuming such a world is possible). The magnitude of our efforts in that world will vary according to the force we exert (which will invariably cause accelerations since it is not counteracted). By contrast, all efforts will have the same intensity in Descartes' world, namely, a null one. This is because intensity is not just a function of the exerted force, it is also a function of the resistance met.

With this in hand, let us return to the difficulty objection. The problem is that efforts' difficulty can be equated neither with their magnitude nor with their intensity. Suppose an adult and a child lift the same pumpkin, at the same height, at the same speed. Lifting the pumpkin is easier for the adult than for the kid. Yet their efforts have the same magnitude: the same force is exerted, *ex hypothesi* by each.[8] Likewise, their efforts have the same intensity: the magnitude of the counteracted part of their exerted force is equal to the weight of the pumpkin. So, the difference in difficulty remains unexplained in the force-based account. There are two strands in that objection to the force-based theory:

Problem 1: An account of the difficulty of effort is needed, the force-based theory does not provide any. What is difficulty?

---

[8] Let us ignore, for the sake of the argument, the difference in the length or their arms and other differences in each agent's bodily mechanics.

Problem 2: Even if difficulty can be accounted for within the force-based theory, it will remain an inessential feature of effort. But difficulty is essential to effort, or so the objection goes.

5 Bradford's account of difficulty

Let us start with the first problem: what is difficulty? Bradford (2015) tackles in detail that so far neglected issue. She claims (1) that difficulty is a property of activities; (2) that this property is relative to agents — or groups of agents: what is difficult for Julie may not be difficult for Paul; (3) That the complexity and the low probability of success of an action should not be conflated with its difficulty (although an action can be difficult in virtue of its complexity). I agree with those three claims, which I shall take for granted hereafter. On that basis, Bradford proposes the following account of difficulty:

Difficulty = $_{\text{Df Bradford}}$ For an activity to be difficult is for it to require sufficient intense effort.

Thus, climbing a pass, swimming against the tide or opening a heavy door are difficult activities because they require much effort. Bradford takes effort to be primitive (but leaves it open that a substantial definition of effort could be given) and gives a thorough account on how to measure effort and what sufficient effort is, which I won't rehearse here. Bradford's account is highly promising when it comes to understanding the difficulty of activities which are not efforts. Her proposal echoes work on task difficulties in motivational psychology, which correlate the difficulties of a task with the amount of effort required to perform that task (Richter et al., 2016). Recall however the distinction drawn in Sect. 3 between efforts and effortful actions. The task or activities targeted by Bradford are effortful actions: that is, actions that are made by making efforts. Bradford's account, no doubt, works very well to explain the difficulty of such effortful actions. But what about the difficulty of efforts themselves? Applied to the difficulty of efforts, Bradford's account raises two circularity worries.

First, using Bradford's definition of difficulty to account for the difficulty of efforts leads to a regress: difficult efforts would be difficult in virtue of further (sufficiently intense) efforts that are required to do. Since those other efforts will presumably be difficult in turn (how could a non-difficult effort explain the difficulty of another?), their difficulty will have to be explained by yet further efforts that they require, etc. The problem is not that second-order efforts are dubious. The (first order) effort of lifting a weight for a certain time could be difficult in virtue of requiring a second-order effort to persevere in that effort. The problem is rather (i) that *any* difficult effort would require a higher-order effort, which seems far from obvious; (ii) that any difficult effort would require an infinity of high-order efforts, which is very implausible.

Second, Bradford's notion of a *sufficient effort* appears to collapse into the notion of a sufficiently *difficult* effort, rendering Bradford's definition of difficulty circular when applied to efforts. Bradford assumes that effort 'comes in varying degrees of

strength, or intensity'. Now the 'intensity' of an effort is an ambiguous expression. It may mean some *objective* amount of force exerted or resisted (similar to the concepts of magnitude and intensity introduced above). Or it may mean a more subjective magnitude in the sense that for the same amount of objective force exerted, different individuals may make efforts of different intensities. Bradford, I submit, must understand intensity of effort not as an objective feature but as a subjective one, that varies across individuals and circumstances. Were it not so, Bradford could not explain the relativity of difficulty (on which she rightly insists): the fact that lifting a pumpkin is more difficult for a child than for an adult. But then, what she means by the intensity of effort can be neither their magnitude nor their intensity, as defined here. It must be instead what we are here calling their difficulty. To be clear, Bradford never explicitly speaks of the difficulty *of efforts*.[9] I maintain, however, that when Bradford speaks of the intensity of effort, she means what we here call the difficulty of effort. If true, Bradford's account may well succeed in explaining the difficulty of activities in terms of the difficulty of efforts. Still, Bradford's account of difficulty cannot be used to shed light on the difficulty *of efforts*, for it constitutively relies on it.

Although Bradford's account of difficulty cannot be directly applied to the difficulty of effort, one key insight should be retained from it. Namely, that the nature of difficulty depends on the nature of effort. In other words, we should not define effort through difficulty, but we should characterize difficulty in terms of effort. My positive proposal elaborates on this insight.

6 Difficulty for the force-based account

In a nutshell, I propose that difficulty is an undefinable, feelable, value-like property which accrues to efforts partly in virtue of their intensity, and partly in virtue of some other factors such as the agent's capacities (strength, skills) and states (fatigue, health). Though difficulty is a primitive property of (some) efforts, much can be said about what bears and grounds it. I propose five essential claims connecting difficulty with efforts:

Thesis 1: Actions which are not efforts, if they are difficult, are difficult in virtue of being related to difficult efforts. By contrast, only efforts can be fundamentally difficult.

Difficulty, which is essentially a property of action (as Bradford rightly argues), is fundamentally a property of efforts. What does that mean? I have argued in Sect. 3 that some non-basic actions are effortful because they are made by making an effort.

---

[9] In fact, given that Bradford mostly uses adverbials to express effort ("with effort", "effortfully") or the attributive "requiring effort" prefaced by an action name or description, I suspect that she has in mind some adverbial theory of effort according to which efforts are not actions, but some modification of action. If so, she could maintain that speaking of the difficulty of efforts does not make sense: it is the actions made with effort which are difficult, not the efforts. However, if I am right that effortful actions boil down to non-basic actions made by making efforts (see again Sect. 3), this adverbial move should be avoided.

Expanding on this proposal, I now suggest that effortful actions are difficult in virtue of the difficulty of the efforts by which they are performed. The opening of the door (which is not an effort but an effortful action) is difficult because the pushing of the door (which is an effort) is difficult. Incidentally, note that on top of their basic difficulty, some efforts may inherit difficulty from other efforts they depend on. In the case of second-order efforts – e.g., persevering in a first-order effort in spite of its difficulty, such as continuing to lift a heavy weight – the total difficulty of the first-order effort includes its own fundamental difficulty plus the difficulty inherited from the second-order effort of perseverance. Bradford is right that difficulty always arises from effort; but the reason why it is so, which her account fails to exhibit, is that efforts are difficult.

Thesis 1 captures an essential link between difficulty and its fundamental bearers, namely efforts. The next four theses capture essential links between efforts' difficulty and some properties on which difficulty depends.

Thesis 2: Efforts' difficulty depends on some lower-order properties of the effort, of the agent, of its environment, etc.

This proposal builds on the idea that difficulty is a value-like property. It is often said that values, contrary to e.g., colours, are *conceptually supervenient properties*: while it makes sense to think of a flower as being red, without further ado, a flower can only be beautiful in virtue of some other non-axiological property it exemplifies (such as its colour, shape…). Like value, difficulty depends for its exemplification on other properties of its bearers. Difficulty cannot alight directly on actions. Actions – and efforts in particular – are difficult in virtue of some of their lower-order properties.

Thesis 3: The lower-order properties on which effort's difficulty depends include:

- the intensity of the effort;
- the capacities of the agent (strength, skill…) and some states of the agent (fatigue, health, repletion…) affecting those capacities.

These features together, I submit, can be represented by the ratio of the exerted force to the agent's maximal exertable force used in sport sciences. The exerted force represents the intensity of the effort; the maximal exertable force represent the capacity of effort of the agent (i.e., his strength) at a given time, given his condition at that time (his fatigue, repletion…). But is this ratio really taking into account the intensity of the efforts rather than their magnitude? That is, is it a ratio between *counteracted* exerted forces, rather than a ratio between exerted forces *tout court*, counteracted or not? It is indeed a ratio of the first kind: the maximal or peak force is standardly defined as the force exerted when the velocity, e.g., in load lifting, reaches zero (see Peterson, M. D., Alvar, B. A., & Rhea, M. R. 2006). That is, the maximal force exerted corresponds to a fully counteracted effort (and to isometric muscle contractions, see Sect. 3). It is thus really the intensity of the maximal effort (by contrast to its magnitude) which is considered in this ratio. The same is true of the actual effort,

so that the ratio of the exerted force to the agent's maximal exertable force indeed integrates the effort's intensity with the agent's capacities.[10]

Thesis 3 identifies the lower-order properties mentioned in thesis 2. One key idea here is that the intensity of an effort, although distinct from its difficulty, is related to it: an effort's intensity is one of the difficulty-making properties. Effort deprived of intensity – efforts in Descartes's world, if such efforts were possible – cannot be difficult. On the other hand, it is because efforts' difficulty does not *only* depend on efforts' intensity —but also on agent's capacities— that efforts of a same intensity can have different degrees of difficulty across individuals or situations.

Thesis 4: Everything else being equal, the more intense an effort, the more difficult it is.

Thesis 4 introduces a dependency between degrees of intensity and degrees of difficulty. If two persons of the same strength, fatigue, skills, health, etc., make efforts of different difficulties, their efforts must have different intensities. The one who makes a more difficult effort overcomes a greater resistance.

Thesis 5: Intensity of efforts is the *source* of efforts' difficulty; agent's capacities (strength, skill…) and states (fatigue, health, repletion…) are only necessary conditions of efforts' difficulty.

Thesis 5 builds on the distinction between the *condition* and the *source* of a property; or, in Dancy ([2006](#), Chap. 3)'s terminology: the distinction between *favourers* and *enablers*. The idea is that among the properties which determine difficulty, one should distinguish the properties that explain difficulty (analogous to Dancy's favourers) from the properties that, while not explaining difficulty, are nonetheless required for the explainers to explain difficulty (analogous to Dancy's enablers). I suggest that the intensity of efforts is the source of their difficulty, while the level of the agent's strength, her health and fatigue are background conditions of efforts' difficulty.

The intuition sustaining theses 4 and 5 is that the resistance encountered is key to the difficulty of an effort. Unresisted efforts are not difficult: the more adversity, the more difficulty. By contrast, the magnitude of effort, which is independent from the resistive force encountered, does not ground any variation in difficulty. Efforts in Descartes's world (if possible) are all equally difficult: they have a null difficulty.

Let me wrap up. The force-based theory of effort is open to the objection that the best it can do is to analyze the magnitude and intensity of effort, but that it cannot

---

[10] One referee has suggested that the observed phenomenon may simply be an artifact arising from the optimal methods used for force measurement. Indeed, it has been argued that it is even metaphysically impossible to directly measure the magnitude of forces without introducing counteracting forces: falling scales cannot measure weight (see Massin, [2017b](#)). However, if the magnitude rather than the intensity of forces was really the target of such measurements, one could as well measure it indirectly, without any loads, from accelerations and mass. More precisely, one could establish the ratio of the actual bodily acceleration to the maximal accelerations achievable by the subject. While I don't see any decisive objections to this possibility, it appears that measuring effort without considering resistance and relying solely on kinematic measurements overlooks a key aspect. Loads or other resistive devices are not merely measurement tools; they constitute an integral part of the task we are attempting to gauge in terms of intensity.

account for the difficulty of effort. In response, I have argued that the intensity of effort is a key *explanans* of effort's difficulty, so that contrary to initial appearance, the force-based account is in fact in an ideal position to shed light on the elusive property of difficulty.

At this juncture, one may raise the following worry: we now know what the bearers of intrinsic difficulty are —efforts—, we know what it depends on —strength, capacity, states of the agent…—, we know its source —intensity; but we still do not know *what difficulty is*. As I said, I do not think difficulty can be analyzed or defined. But that does not mean that we do not know it. We know it by experience: efforts feel difficult. Ceteris paribus, the effort of lifting a medium weight feels less difficult than the effort of lifting a heavier weight. Likewise, the efforts of lifting the same weight again and again feel more and more difficult. Some will conclude from this that effort's difficulty is a *quale*, an incorrigible and self-intimating property of efforts on par with painfulness (incorrigible in the sense of not being liable of illusion; self-intimating in the sense of being necessarily experienced or felt). This is compatible with but not entailed by the above. The only thing entailed by the present view in that respect is that difficulty can be felt. I am inclined to think that difficulty, rather than a mind-dependent *quale*, is a mind-independent quality which is exactly what it seems to be when we experience it, but which does not need to be experienced to exist nor to be what it is: some efforts are difficult even if they do not feel difficult. I am also inclined to think that difficulty, having a negative polarity or valence, is better thought of as a thick value: difficulty is not just value-*like*, it *is* a value.[11] But nothing I have said entails this realist axiological approach. Whether a *quale*, a value, or whatever else, effort's difficulty is a feelable property of efforts that satisfy the five theses above.

7 Difficulty is not essential to effort

I have characterized (but not analyzed) the difficulty of efforts in terms of their intensity. But what about the second strand of the difficulty objection? Difficulty, the objection goes, is an essential feature of efforts, so difficulty should figure in the very definition of effort or be logically entailed by it. On the present account, difficulty is neither part of the definition of effort, nor logically entailed by it, so the force-based account of effort should be rejected.

My answer is to deny that difficulty is essential to effort, while maintaining that on the present account, difficulty is still metaphysically necessary to effort. Let me first explain how, on the present account, difficulty may be necessary to effort. At first sight, this proposal clashes with the above claims (i) that there are unresisted efforts, and (ii) that unresisted efforts are not difficult. To reconcile those two claims with the assumption that there are no efforts without difficulty, one only needs to reject the possibility of *pure* unresisted efforts, that is, of unresisted efforts which are not conjoined with resisted efforts. I have indeed cast doubt on the existence of such pure unresisted efforts in Sect. 3. While pure unresisted effort may appear conceptually

---

[11] See Massin, 2017c for a defense of the cognate view that painfulness is not a quale but a real value.

possible when considering Descartes' world, such a world is arguably metaphysically impossible. If inertia is considered a force essential to bodies (whether it is intrinsic or extrinsic to them), any change in the motion of a body will face a resistance as a matter of metaphysical necessity. Pure unresisted efforts become metaphysically impossible: all unresisted efforts must unfold in the context of a broader resisted effort.

Accordingly, on the present proposal, though some efforts are not inherently difficult (unresisted efforts), every effort still necessitates a difficult effort. When lifting a pumpkin, the part of the force exerted by the agent that causes the upward acceleration of the pumpkin —that is, the resultant force— is un-counteracted, so the effort consisting in the production of that force is not difficult. But that effort is part of a wider effort encompassing the exertion of the force counteracted by the gravitational weight of the pumpkin. This latter effort is difficult. Therefore, even though some efforts remain unresisted, all unresisted efforts occur in the context of a wider effort, part of which is resisted. Consequently, while not all efforts are inherently difficult, the statement 'no effort without difficulty' remains valid.

Why maintain that difficulty is necessarily tied to effort while denying that difficulty is essential to effort? This is due to the fact that on the force-based account, difficulty is not part of what efforts are; rather, difficulty arises from the nature of efforts, in conjunction with other factors (agent's capacities). Introducing a necessary accidental property to explain effort's difficulty may sound like a heavy philosophical commitment. But appealing to such properties in philosophy of mind is in fact a quite standard move – albeit rarely explicitly spelled out. Thus, many agree that, as a matter of necessity, pain is intrinsically bad. Few agree, however, that pain's badness is part of pain's nature. The standard view of pain is that it is a mental state, and that its disvalue is not part of what it is but necessitated by what it is.[12] Consider, second, knowledge. Among those who claim that knowledge is necessarily good, few claim that knowledge's goodness is part of what knowledge is. Whether one thinks that knowledge is primitive or can be analyzed, one is likely to believe that the value of knowledge *arises* from its nature instead of *being part of* it. Hence the proposal that difficulty stands to effort in the same way as hedonic badness stands to pain, and in the same way in which epistemic goodness stands to knowledge: a necessary but accidental property. Ortega y Gasset is right after all: *effort is only effort when it begins to hurt*. Still, hurting is not part of what effort is.

8 Conclusion: from physical to mental efforts

To make a physical effort is to exert a force on a body in order to make it move or stay at rest. Each time we exert a force on a body, that body exerts an opposite resistive force, counteracting part of the force we exert. This allows defining the intensity of an effort as the magnitude of exerted force counteracted by the resistive force. Since efforts of equal intensities made by agents of different capacities will not be equally difficult, the intensity of an effort is distinct from its difficulty. Efforts' difficulty is

---

[12] Fine, 2002; Zangwill, 2005; see Massin, 2017c for discussion.

a further property of efforts that supervenes and is grounded on the intensity of the efforts and the capacities of the agent. Once efforts and their difficulty are understood along these lines, it is possible to understand the difficulty of actions which are not efforts along the lines proposed by Bradford: the difficulty of a task which is not an effort, but which is made by making efforts, consists in the difficulty of the efforts it requires.

An important pending issue is whether this force-based account of physical efforts can be extended to non-physical efforts. The efforts to resist a temptation, to understand an obscure text or to seduce somebody are not, on the face of it, exertions of forces. To conclude, I briefly suggest how the force-based theory of effort could be broadened to encompass such scenarios. This expansion necessitates a comprehensive examination of non-physical forces. Although the notion of non-physical forces may raise initial skepticism, it finds recurrent validation in various scientific works, such as studies on psychological forces (Lewin, 1938; Sidgwick, 1981; Wundt, 1902), social and economic forces (Jevons, 1879; Pareto, 1935), and evolutionary forces (Sober, 1984; Pence, 2017). This indicates the existence of a broader concept of force, yet to be fully elucidated, extending beyond the confines of physical forces. I propose that dispelling the enigma surrounding non-physical forces requires the development of a formal theory — a formal dynamics — akin to our existing formal theory of parts. Just as the original concept of a part is inherently spatial, formal mereology enables its extension to non-spatial elements (e.g., temporal parts, elements of propositions, arguments, emotions, institutions, etc.). Similarly, while fundamental topological concepts like betweenness or connectedness traditionally pertain to concrete space, formal topology allows their application to abstract qualitative spaces or abstract mathematical structures. If a formal theory of forces and their impacts can be crafted along similar lines, the act of resisting the temptation to indulge in chocolate could be conceptualized as the application of a non-physical force aimed at counteracting the non-physical force compelling us to indulge.

References

Arena, R., Myers, J., & Kaminsky, L. A. (2016). Revisiting age-predicted maximal heart rate: Can it be used as a valid measure of effort. *American Heart Journal*, *173*, 49–56.

Armstrong, D. M. (1993). *A materialist theory of the mind*. Routledge.

Armstrong, D. M. (1997). *A world of states of affairs. Cambridge*. Cambridge University Press.

Bergevin, M., Steele, J., Payen de la Garandentie, M., Feral-Basin, C., Marcora, S. M., Rainville, P., Caron, J. G., & Pageaux, B. (2023). Pharmacological blockade of muscle afferents and perception of effort: A systematic review with meta-analysis. *Sports Medicine*, *53*(2), 415–435.

Bermúdez, J. P. (forthcoming). What is the feeling of effort about? *Australasian Journal of Philosophy*.

Bermúdez, J. P., & Massin, O. (2023). 'Efforts and their feelings'. *Philosophy Compass*, 18(1).

Biswas, S., & Visell, Y. (2021). Haptic perception, mechanics, and Material technologies for virtual reality. *Advanced Functional Materials*, *31*(39), 2008186.

Borg, G. (1962). *Physical performance and perceived exertion*. Gleerup.

Bradford, G. (2015). *Achievement*. Oxford University Press.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. '*Public Health Reports*, *100*(2), 126.

Cheval, B., & Boisgontier, M. P. (2021). The theory of effort minimization in physical activity. *Exercise and Sport Sciences Reviews*, *49*(3), 168–178.

Cleveland, T. (2016). *Trying Without Willing: An Essay in the Philosophy of Mind* (first ed. 1997). London: Routledge.

Dancy, J. (2006). *Ethics without principles*. Oxford University Press.

Davidson, D. (1971). Agency. In R. Binkley, R. Bronaugh, & A. Marras (Eds.), *Agent, Action, and reason*. University of Toronto.

de Vignemont, F., & Massin, O. (2015). Touch. In M. Matthen (Ed.), *Oxford Handbook of philosophy of perception*. Oxford University Press.

Demanet, J., Muhle-Karbe, P. S., Lynn, M. T., Blotenberg, I., & Brass, M. (2013). Power to the will: How exerting physical effort boosts the sense of agency. '*Cognition*, *129*, 574–578.

Fales, E. (1990). *Causation and universals*. Routledge.

Feynman, R. (1963). *The Feynman lectures on physics*. Addisson-Wesley.

Fine, K. (2002). 'The Varieties of Necessity.' *Conceivability and Possibility*, pp. 253–281.

Fricke, M. F., & Snowdon, P. (2003). *'Solidity and Impediment ' Analysis* 63:173–178.

Gasset, J. O. Y. (1968). *Deshumanizacion Del Arte E ideas Sobre La Novela*. Princeton University Press.

Jevons, W. S. (1879). *The theory of political economy*. Macmillan and Company.

Kurniawan, I. T., Seymour, B., Talmi, D., Yoshida, W., Chater, N., & Dolan, R. J. (2010). Choosing to make an effort: The role of striatum in signaling physical effort of a chosen action. *Journal of Neurophysiology*, *104*, 313–321.

Lederman, S., & Klatzky, R. (2009). 'Haptic perception: A tutorial'. *Attention, Perception, & Psychophysics*, 2009, vol. 71, no 7, 1439–1459.

Lewin, K. (1938). *The conceptual representation and the measurement of psychological forces*. Duke University Press.

Lhuillier, S., Gyselinck, V., Dutriaux, L., Grison, E., & Nicolas, S. (2018). « like a ball and chain »: Altering locomotion effort perception distorts spatial representations. *Journal of Environmental Psychology*, *60*, 63–71.

Loy, B. D., Cameron, M. H., & O'Connor, P. J. (2018). Perceived fatigue and energy are independent unipolar states: Supporting evidence. *Medical Hypotheses*, *113*, 46–51.

MacIntosh, B. R., MacDougall, K. B., Falconer, T. M., & Holash, R. J. (2021). In support of the continued use of the term anaerobic threshold. *The Journal of Physiology*, *599*(5), 1709–1710.

Marshall, C. (2015). Hume versus the vulgar on resistance, nisus, and the impression of power. *Philosophical Studies*, *172*, 305–319.

Massin, O. (2009). The metaphysics of forces. *Dialectica*, *63*(4), 555–589.

Massin, O. (2017a). Towards a definition of efforts. *Motivation Science*, *3*(3), 230–259.

Massin, O. (2017b). The composition of forces. *The British Journal for the Philosophy of Science*, *68*, 805–846.

Massin, O. (2017c). Bad by Nature, an Axiological Theory of Pain. In J. Corns (Ed.), *The Routledge Handbook of Philosophy of Pain* (pp. 319–333). Routledge.

Massin, O. (2022). Resisting phenomenalism, from bodily experience to mind-independence. In Alsmith Adrian, & S. Andrea (Eds.), *The Routledge Handbook of Bodily Awareness* (pp. 58–69). Routledge.

Massin, O. (2014). 'Quand Vouloir, c'est Faire'. In R. Clot-Goudard (Dir.), L'Explication de L'Action. Analyses Contemporaines, *Recherches Sur la Philosophie Et le Langage* N°30, Paris, Vrin: 79–114.

Newton, I. (1999). *The Principia, Mathematical principles of Natural Philosophy*. University of California Press.

Nickel, M., Scheer, C., Hammel, J. U., Herzen, J., & Beckmann, F. (2011). The contractile sponge epithelium sensu lato – body contraction of the demosponge Tethya Wilhelma is mediated by the pinacoderm. *Journal of Experimental Biology*, 214, 1692–1698.

Pageaux, B. (2016). Perception of effort in exercise science: Definition, measurement and perspectives. *European Journal of Sport Science*, 16, 885–894.

Pareto, V. (1935). *The mind and society*. Brance and Company.

Pence, C. H. (2017). Is genetic drift a force? *Synthese*, 194(6), 1967–1988.

Perkins, M. (1983). *Sensing the world*. Hackett Pub. Co.

Peterson, M. D., Alvar, B. A., & Rhea, M. R. (2006). The contribution of maximal force production to explosive movement among young collegiate athletes. *The Journal of Strength & Conditioning Research*, 20(4), 867–873.

Poole, D. C., Rossiter, H. B., Brooks, G. A., & Gladden, L. B. (2021). The anaerobic threshold: 50+years of controversy. *The Journal of Physiology*, 599(3), 737–767.

Richter, M. (2015). Goal pursuit and energy conservation: Energy investment increases with task demand but does not equal it. *Motivation and Emotion*, 39(1), 25–33.

Richter, M., & Wright, R. A. (2014). Contemporary perspectives on effort: A special issue. *Motivation and Emotion*, 38, 745–747.

Richter, M., Gendolla, G. H., & Wright, R. A. (2016). Three decades of research on motivational intensity theory: What we have learned about effort and what we still don't know. *Advances in Motivation Science*, 3, 149–186.

Robles-De-La-Torre, G. (2008). Principles of haptic perception in virtual environ- ments. *Human haptic perception: Basics and applications* (pp. 363–379). Springer.

Robles-De-La-Torre, G., & Hayward, V. (2001). Force can overcome object geometry in the perception of shape through active touch. *Nature*, 412, 445–448.

Ruben, D.-H. (2018). *The metaphysics of action: Trying, doing, causing*. Palgrave Macmillan.

Ruthmann, A., Behrendt, G., & Wahl, R. (1986). The ventral epithelium of Trichoplax adhaerens (Placozoa): Cytoskeletal structures, cell contacts and endocytosis. *Zoomorphology*, 106, 115–122.

Sanford, D. H. (1976). The primary objects of perception. *Mind LXXXV*:189–208.

Schmidt, L., Lebreton, M., Cléry-Melin, M. L., Daunizeau, J., & Pessiglione, M. (2012). Neural mechanisms underlying motivation of mental versus physical effort. '*PLoS Biology*, 10, e1001266.

Schrenk, M. (2014). Die Erfahrung Der Widerständigkeit Der Welt als Wahrnehmung Kausaler Kraft. *Vermögen Und Handlung* (pp. 23–62). Brill mentis.

Sidgwick, H. (1981). *The Methods of Ethics*. Hackett.

Sober, E. (1984). *The nature of selection: Evolutionary theory in philosophical focus*. University of Chicago Press.

Steele, J. (2020). 'What is (perception of) effort? Objective and subjective effort during task performance.' *PsyArXiv*.

Svedahl, K., & MacIntosh, B. R. (2003). Anaerobic threshold: The concept and methods of measurement. '*Canadian Journal of Applied Physiology*, 28, 299–323.

Taylor, R. (1973). *Action and purpose*. Humanities.

Turvey, M., & Carello, C. (1995). Dynamic touch. In J. Cutting, P. Vishton, W. Epstein, & S. Rogers (Eds.), *Handbook of perception and cognition: Vol. 5. Perception of space and motion* (pp. 401–490). Academic.

Von Kriegstein, H. (2017). Effort and achievement. *Utilitas*, 29, 27–51.

Waismann, F. (1994). Will and motive., *In Ethics and the Will: Essays*, trad. H. Kaal. Kluwer. 53–136.

Weber, & Weber, E. H. (1905). *Tatsinn and Gemeingefuhl*, Verlag von Wilhelm Englemann, Leipzig, Germany (1905), English transltion by H. E. Ross and D. J. Murray, (1996) eds. *E.H. Weber on the tactile senses*, Hove: Erlbaum (UK) Taylor & Francis.

Westbrook, A., & Braver, T. S. (2015). Cognitive effort: A neuroeconomic approach.' *Cognitive. Affective & Behavioral Neuroscience*, 15, 395–415.

Wilson, J. (2007). Newtonian forces. *The British Journal for the Philosophy of Science*, 58, 173–205.

Wilson, J. (2009). The causal argument against component forces. *Dialectica*, 63, 525–554.

Wundt, W. M. (1902). In C. H. Judd (Ed.), *Outlines of psychology*. W. Engelmann.

Zangwill, N. (2005). Moore, morality, supervenience, essence, epistemology. *American Philosophical Quarterly*, *42*, 125–130.

Zénon, A., Sidibé, M., & Olivier, E. (2014). Pupil size variations correlate with physical effort perception. '*Frontiers in Behavioral Neuroscience*, *8*, 286.