Please cite as:
Bermúdez, J. P. & Massin, O. (Forthcoming). Efforts and their Feelings. *Philosophy Compass.*

Efforts and their Feelings

Juan Pablo Bermúdez[1]
Olivier Massin[2]

Abstract: Effort and the feeling of effort play important roles in many theoretical discussions, from perception to self-control and free will, from the nature of ownership to the nature of desert and achievement. A crucial, overlooked distinction within the philosophical and scientific literatures is the distinction between theories that seek to explain effort and theories that seek to explain the feeling of effort. Lacking a clear distinction between these two phenomena makes the literature hard to navigate. To advance in the unification and development of this area, this article provides an overview of the main theories of the nature of effort and the nature of the feeling of effort, and then discusses how efforts and their feelings are related. Two key takeaways emerge. First, there is widespread agreement that efforts are goal-directed actions. Second, one of the main philosophical issues to be decided is whether feelings of effort should be defined by reference to efforts (effort-first approach), or whether efforts are defined by reference to the feeling of effort (feeling-first approach).

Research on effort is as abundant as it is scattered. First, literatures on different kinds of efforts remain largely isolated from one another; for instance, works on cognitive efforts, on the one hand, and on physical efforts on the other, rarely overlap. Second, efforts cut across many research areas (psychology, exercise sciences, economics, philosophy…) which pursue different goals and are based on different conceptual frameworks and terminologies. Efforts are sometimes approached in decision-theoretic terms, in mechanistic terms, in cognitive terms, in physiological terms, etc. This renders interdisciplinary integration of research on effort challenging. Third, integration of research on effort is hampered by the multiplicity of definitions of the term, which often remain tacit or inchoate. Few attempts have been made so far at mapping existing definitions (Massin, 2017; Steele, 2020; von Kriegstein, 2017). Fourth, the question of the relation between efforts and their feelings is

[1] Universidad Externado de Colombia, Imperial College London & Université de Neuchâtel, juanpa@gmail.com.

[2] Université de Neuchâtel, olivier.massin@unine.ch.

largely left unaddressed. Consequently, the connection between the literature on effort and the literature on the feeling of effort remains murky.

This overview seeks to help reduce the fragmentation of effort research. We present and assess the main theories of effort (§1), then consider theories of the feeling of effort (§2), and finally assess some proposals for bridging theories of effort with theories of the feeling of effort (§3).

Two preliminaries are in order. First, the distinction between *objective* and *subjective effort* is widespread in the scientific literature on effort, the former referring to the effort made by the agent, the later to the agent's feeling or experience of effort. We agree with the distinction but think that "subjective effort" is a misnomer. The feeling of a stone is not a subjective stone; by parity, the feeling of an effort is not a subjective effort. So, we propose that the distinction between objective and subjective efforts be replaced with the distinction between efforts and feelings of effort. Sometimes 'subjective effort' is used to mean, not the feeling of effort, but felt effort, rendering the expression ambiguous. An analogous objection applies here. A felt stone is not the feeling of a stone (nor is a seen house the seeing of a house); by parity, a felt effort is not the same thing as the feeling of effort. We shall therefore eschew any talk of subjective efforts and talk instead of feelings of effort on the one hand, and efforts on the other. (We take 'feeling of effort' to be synonymous with 'perception of effort' and 'sense of effort'.)

Second, efforts come in many varieties: we make physical efforts (lifting heavy pumpkins), mental efforts (mentally rotating a pumpkin), mixed efforts (carefully carving a pumpkin for a design contest), economic efforts (allocating scarce financial resources to the pursuit of a goal), social efforts (directed at convincing or influencing others), collective efforts (pursued jointly through coordinated action), and so on. We focus here on the mental and physical varieties, acknowledging that these are only some of the efforts that require explanation. Indeed, a key challenge is to provide a unified framework to account for all the different kinds of effort.

1. Theories of Effort

Three main families of theories target the nature of effort: force-based, resource-based, and mediation theories. This section examines each one, along with their strengths and drawbacks.

1.1. Force-Based Accounts

Force-based theories define efforts as exertions of forces against some resistive force in order to reach some goal. The effort of lifting a pumpkin consists in exerting a force on the pumpkin to move it upwards, and the resistive force is the pumpkin's weight. Such theories have been adopted by philosophers and psychologists interested in the idea that resistance to our effort provides us with the impression of an external world (Destutt de Tracy, 1801; Dilthey, 2010; Maine de Biran, 2000, 2002; Peirce, 1935; Stout, 1931). Recently, force-based theories have been defended by Kruglanski et al. (2012); de Vignemont and Massin (2015); and Massin (2017). Force-based accounts of effort should not be conflated with so-called peripheralist views about the *feeling* of effort. Peripheralism

(James, 1880) (James, 1855) is the view that the feeling of effort consists in the feeling of muscle contractions, as opposed to centralism (Helmholtz, 1866), according to which the feeling of effort represents motor commands. Unlike peripheralism, force-based accounts are about effort and not about the feeling of effort. Additionally, the latter equate effort not with sheer muscle forces—which may be non-agential (as in cramps)—, but with the exertion of such forces to reach some goal. (For more on peripheralism and centralism see §2.1 below.)

Force-based theories correspond to the etymology and common dictionary definitions of 'effort' and have several appealing features. First, the idea of a resistance is naturally included in the definition: the effort consists in the force one exerts, and the resistance in the opposite forces one encounters. Second, force-based theories neatly define an effort's success conditions: an agent's effort succeeds if she attains her goal, non-deviantly, through her force exertion, and fails otherwise. Third, force-based theories clearly distinguish the intensity of efforts from their success or failure. Bob may exert an intense force on a pumpkin and fail to lift it, or exert a small force on an acorn and succeed in lifting it.

Force-based theories face two main challenges. The first is accounting for the difficulty of efforts. Lifting the same pumpkin is more difficult for a child than for an adult, yet both must exert the same amount of force to succeed (cf. Preston & Wegner, 2009 for similar phenomena). The force-based theorist may initially argue that any physical effort requires a second-order mental effort: lifting the pumpkin requires exerting both a physical force on the pumpkin and a mental force to avoid disengaging from that first-order effort. The child's effort is thus more difficult because it requires a more intense mental effort. But this seems to presuppose rather than explain difficulty: for why should the child's first-order physical effort require a greater mental effort? The natural answer—that the physical effort is more difficult for the child—is circular. A second answer to the objection is that an effort's difficulty is a property that supervenes not only on the intensity of the exerted force but also on other properties including the agent's capacities, fatigue, and skills (Massin, 2022). Accordingly, researchers often measure a physical effort's intensity not as merely the exerted force's intensity, but as the ratio of the exerted force and the agent's maximum force (Kurniawan et al., 2010; Schmidt et al., 2012; see also von Kriegstein, 2017).

The second challenge for force-based theories is that of explaining non-physical efforts. In the case of mental efforts —such as the example of resisting a temptation— no muscular force is exerted. Can we appeal to mental forces? Physical forces can be measured, and we have well-established theories explaining how they compose with each other and cause accelerations, but mental forces are more controversial. The best move for the force-based theorist would be to provide a formal theory of forces, which is not restricted to physical forces. In the same way as formal theories of parthood allow extending the concept of part to non-material parts (e.g. temporal parts, parts of propositions, of mental states, of institutions…), a formal theory of forces would make it possible to apply the concept of force to non-physical entities such as desires, social norms or economic incentives. That such a formal theory is needed and attainable is suggested by the widespread appeal in the technical

literature to psychological forces (Lewin, 1938; Sidgwick, 1981; Wundt, 1902); social and economic forces (Jevons, 1879; Pareto, 1935) or evolutionary forces (Pence, 2017; Sober, 1984).

1.2 Resource-Based Accounts

Resource-based theories define efforts as the use of some limited resource to reach one's goal (Gendolla & Wright, 2009; Szwed et al., 2021; von Kriegstein, 2017; Wright, 2016). While both force- and resource-based accounts equate efforts with goal-directed actions, on the force-based account an effort consists in the action of exerting forces (a force being a *vectorial* quantity having both a magnitude and a direction), while on the resource-based account an effort is a transfer/allocation/investment/expenditure of a resource (which is a *scalar* quantity having a magnitude but lacking direction).[3] A resource-based perspective is naturally suggested by ordinary expressions such as 'investing effort' or 'putting effort into'. Note that such expressions are synecdochic: strictly speaking it is not effort that is invested, but some resource, the investment of which constitutes effort.

Like force-based theories, resource-based theories offer a promising account of effort's success conditions: an agent's effort succeeds if they non-deviantly attain their goal through their resource investment, it fails otherwise. Resource-based accounts can also clearly distinguish an effort's intensity from its success or failure. Bob may allocate a great amount of resources to lift a pumpkin and still fail, or he may allocate very little resources to lifting an acorn and succeed.

Difficulty also constitutes a challenge for at least some resource-based accounts. The same level of resource expenditure may correspond to different difficulty levels across individuals. Likewise, dedicating all of one's attention to a given task may prove easier for some people than for others. Resource-based accounts also face a problem in explaining non-physical efforts: expenditures of mechanical energy are well-understood, but what is the resource that decreases in case of mental effort? However, resource-based theories have the edge here as some alternatives have been explored in the psychological literature. An influential, albeit controversial, proposal states that using *willpower* to make mental efforts would lead to states of "ego depletion" characterized by lower regulation capacity (Baumeister et al., 2000; Hagger et al., 2010). While ego-depletion models have been quite influential in philosophy (Bayne & Levy, 2006; Holton, 2009; Levy, 2011), the scientific research program has been questioned on methodological grounds, so much so that it is currently by and large considered a failed paradigm (see Carter & McCullough (2014) for a critical meta-analysis, Friese et al. (2018) for a useful summary of the discussion, and Vohs et al. (2021) for a severe replication failure). The metabolic process of glucose reduction was posited as ego depletion's

[3] That said, just as force-based and energy-based classical mechanics are "exactly equivalent" (since the laws of classical mechanics can be formulated in either of these: see Feynman, 1964), force-based and resource-based accounts of effort may be similarly equivalent (see Massin, 2017).

physiological counterpart (Gailliot et al., 2007; Gailliot & Baumeister, 2007), but the proposal has been shrouded in replication failures (Dang, 2016, p. 206; Vadillo et al., 2016).

One further problem for theories appealing to depletable resources is the role of motivation in effort exertion: studies have found that, even after people have performed depleting actions, the decrease in performance on a second task is smaller if they are given extra incentives; one would not expect these motivational effects to occur if efforts were mere depletions of a limited resource (Friese et al., 2018). This seems to speak in favor of resource-based theories that appeal not to depletable resources but to resource limitations. Attention, for instance, is limited in this sense: you can only attend to so many items at a time. Such limitations put pressure on agents to allocate these resources appropriately (see §2.3 for more discussion of this issue).

While resource-based accounts are more developed than force-based accounts when it comes to explaining non-physical efforts, the latter capture more naturally the idea that efforts meet some *resistance*. Resource-based accounts can argue that some tasks require more energy (the heavier the pumpkin, the more energy would have to be transferred to it to lift it), but they cannot appeal to the intuitive idea of lesser or greater resistance to explain these differences.

1.3 Mediation accounts

A recently influential alternative identifies effort with the process that mediates between capacity on the one hand, and performance, on the other (Shenhav et al., 2017). Effort, or the lack thereof, is what explains the difference between an organism's maximum possible task performance (the performance it is capable of at maximum exertion given the task's characteristics) and its actual performance (the level of task performance observed in a given situation). The greater the effort, the closer the actual performance is to the agent's maximal capacity. Thus, an organism may have the ability to run at a maximum of 20 km/h, but may be observed to run at only 10 km/h because it allocates only a limited amount of effort to the task.

Such accounts state that effort plays a mediating function, but it does not yet specify what this mediating factor corresponds to: is it some action, some feeling, some sub-personal neural or physiological process…? A response can be found in Inzlicht et al.'s (2018, p. 338) identification of the mediation process with the "subjective intensification of mental and/or physical activity in the service of meeting some goal". So, in in its full version, this theory states that effort is the agent's intentional intensification of her activity, which has the function of bringing her actual performance closer to her maximal possible performance.

The mediation account has recently gained popularity among mental effort theorists (Kool & Botvinick, 2018; Székely & Michael, 2021), perhaps due to some of the following advantages. First, by relativizing an effort's intensity to both the features of the task and the agent's abilities, mediation theories can explain why the same performance can have different levels of difficulty for agents with different characteristics. (Lifting the same pumpkin will require greater activity intensification for a child than for an able-bodied adult.) Second, motivation can be included as one of the variables

determining the level of effort agents choose to exert: the higher the motivation, the greater the activity's intensification and the closer actual performance will approximate its maximum level. Third, by not positing a depletable resource, the mediation account provides an alternative to ego depletion-style views which have been plagued by methodological and replication problems.

However, mediation accounts face challenges. First, they assume that an increase in effort leads to an increase in performance; but this need not be the case (Westbrook & Braver, 2013). In fact, the amount of effort is frequently uncorrelated with the degree of task success: an agent can exert a lot of effort and do just as poorly as another similarly able agent who exerts much less. People solving Cognitive Reflection Test questions (e.g. "A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?": see Frederick, 2005) can work very hard trying to find the right answer and still fail to do so. Worse, effort is sometimes *inversely* correlated with performance. Take the case of 'the yips', a sports performance breakdown that occurs when athletes try to exert explicit, effortful control over aspects of a well-practiced action that they should leave to automaticity and intuition (Bermúdez, 2017). Thus, mediation accounts seem to lead to the wrong view about the relationship between effort and performance success. Performance success is not determined only by effort intensity; it depends also on skill (how you exert your effort).

Second, the notion of "subjective intensification of activity" stands in need of clarification. To intensify an activity, there must be an activity there to be intensified. But the distinction between the goal-directed activity and its intensification, in several concrete cases, appears to be a distinction without a difference. The effort often begins at the very same time as the activity, suggesting that the effort is not the activity's intensification, but the activity itself. Think, for instance, of explosive efforts (highly effortful and very short bursts of activity, typically lasting 0.1–0.2 seconds, such as starting a 100m race or the initiation of a bout of weightlifting), an effort to begin working, or an effort of overcoming fear to raise one's voice against injustice. In these cases, merely initiating the action is itself an effort, even before any intensification. But if so, not all efforts can be described as intensifications of already-existing activities. Intensifying such activities would thus constitute the intensification of already ongoing efforts; so mediation theory's definition risks circularity, as it would define efforts as intensifications of efforts.

Although the three main theories of efforts presented above diverge in important respects, they all agree on two crucial points often left implicit. First, *efforts are actions*: exerting a force, allocating a resource, and intensifying an activity are all kinds of actions. Second, all these theories equate efforts with actions made to reach some goal: we exert forces/employ resources/intensify activities/exert our will *in order to* achieve some end.[4] These two points fit with our ordinary talk and thinking about effort: we talk of people making efforts; we hold people accountable for the efforts they make or fail to make; we intend, promise, decide, resolve, order or have duties to make efforts; we engage or

[4] Bradford (2013) suggests that efforts are exertions of one's will. In so far as exerting one's will is a goal-directed action, it conforms with our general claim.

participate in efforts; we describe efforts as feeble, vigorous, relentless, resolute, brave, mighty, cruel, or generous. These expressions would make little sense if efforts were not purposive actions.

2. Theories of the Feeling of Effort

The feeling of effort has long been associated with exercises of agency and the will (Bayne & Levy, 2006; James, 1880). While traditionally centered around the feeling of physical effort, researchers have recently made ground-breaking advances in the study of the feeling of mental effort. This section reviews theories that investigate the feeling of effort largely independently from theories of efforts themselves, and the issues surrounding them.

2.1. Peripheralism vs. Centralism

An intuitive account holds that feelings physical effort arise out of muscle contractions involved in the production of strenuous physical activities. Such *peripheralist* view has been opposed by *centralists* who hold that the feeling of effort is the conscious experience of efferent commands of the central nervous system towards the muscles.

While peripheralism-centralism debates exist since at least the 19th century and continue to this day, progress has recently been achieved through both conceptual clarification and empirical findings. Conceptually, the feeling of effort must be distinguished and measured independently from other feelings associated with muscular activation, particularly the feeling of fatigue (Pageaux, 2016). Empirically, recent research used epidural anesthesia to block afferent signals from the muscles to the nervous system while participants perform effortful physical activities. These studies have shown that, when the feeling of effort is measured separately from other performance-related feelings, reports of sensations of effort increase as physical exertion increases *even when* afferent signals are blocked (Bergevin et al., 2021). Evidence of this kind leans in favor of centralism.

2.2. Comparator Accounts

An influential proposal meant to combine the upsides of peripheralism and centralism holds that the feeling of effort arises from a comparison between the efferent order sent by the will and the subsequent afferent feedback signals received from the body (Jeannerod, 1983; Lafargue & Franck, 2009; Pacherie, 2008). In cases of partial mismatch (i.e. "prediction error") between central command and afferent feedback, a feeling of effort arises. This account, anticipated by Dilthey (2010), found its first technical formulation in von Holst and Mittelstaedt's (1950) description of the efference-copy mechanism, and has since been constantly refined (Frith, 2012). Such *comparator models* have been used to explain the phenomenology of agency as well as various related delusions and pathologies (Bayne, 2011; Blakemore et al., 2002; Haggard, 2005).

Pacherie (2008) relates the feeling of effort with prediction error signals: in absence of such signals, the agent experiences the action as effortlessly under control; but the feeling of effort accompanying these signals communicates to the agent that she ought to exert control over her action. The feeling

of effort thus signals an action's precariousness and the need for the agent to increase control (Lukitsch, 2020).

One problem for comparator accounts is that, by linking the feeling of effort with the prediction error signal, they in effect equate the former with a sense of (partial) failure (Massin, 2017). Such a sense of failure is distinct from the feeling of effort because there is no systematic correlation between an action's degree of failure or success and the feeling of effort's intensity. A brief and intense effort can be successful, but if the feeling of effort signals failure, if should feel effortless. Additionally, if an agent successfully reduces the prediction error by increasing her effort, the action should feel less effortful as her effort increases. Thus success/failure, on the one hand, and effortfulness/effortlessness on the other, appear to be independent distinctions.

A second issue concerns action guidance. Comparator accounts depict the feeling of effort as signaling to the agent that the current state is aversive: intervention is needed if the ongoing action's precariousness is to be corrected. From this perspective, the state's aversiveness may motivate the agent to either intensify control over the action or disengage from it. However, as we will see below (§2.3), the sense of effort is generally agreed to motivate agents to disengage from, rather than increase engagement with, the action. If so, comparator accounts would misrepresent the feeling of effort's motivational profile by depicting it as equally motivating intensification or disengagement.

2.3. Choice-Based Accounts

Efforts are typically experienced as aversive, and this biases agents toward effort avoidance, a tendency reflected in a venerable principle captured by the so-called "principle of least effort" or "law of less work" (Hull, 1943): agents select actions that minimize effort, all else being equal. The principle applies particularly to mental efforts: humans are traditionally considered to behave as "cognitive misers" (Taylor, 1981) who tend to avoid cognitively demanding solutions to a problem and rely on simple heuristics. The research program around motivational intensity theory has shown that agents exert effort only to the extent to which expected outcomes justify it and success is sufficiently likely (Brehm & Self, 1989; Gendolla et al., 2019; Silvestrini et al., 2021). Recently developed methods have been used to show that, in deciding what to do, an action's demand for cognitive effort registers as a cost that counts against its selection (Kool et al., 2010; Westbrook et al., 2013).

All this robustly supports the view that effort generally feels aversive. But *why* is the feeling of effort aversive? Efforts often contribute to fitness and long-term value (working hard leads to good professional outcomes, avoiding excess sweets maintains health, emotional regulation preserves advantageous community bonds), so effort aversiveness calls for an explanation.

To explain this aversiveness, *choice-based accounts* propose that the feeling of effort plays a role not at the level of action *execution* (as per comparator accounts), but at the level of action *selection*. Its function is to help us make choices that maximize the value we obtain with the limited agentive capacities and resources we have at our disposal. These limitations are many and varied: we can move in only one direction at a time; generate forces of only a certain magnitude and a certain duration; concentrate on only so many mental representations at once and just for a limited time; and so on. Agents like us, with complex but limited capacities that we must use to pursue multiple goals, must navigate tradeoffs to make the best of these capacities. Choice-based accounts state that the aversive phenomenology of effort is there to guide agents *away* from actions that are unlikely to maximize the value they can achieve.

Particular choice-based theories differ with respect to which tradeoff the feeling of effort helps us navigate. According to one influential approach, the feeling of effort helps us navigate tradeoffs between valuable but mutually exclusive actions. Since we often cannot perform more than one complex action at a time (we cannot simultaneously read a Jane Austen novel and go swimming, or study and party), we must pick the action likely to yield the most value. *Opportunity-cost accounts* (Kurzban et al., 2013) posit a sub-personal 'cost-benefit calculator' mechanism which estimates the expected value of each salient action alternative, and selects the one with highest expected value. The next-best action's expected value is equivalent to the former's opportunity cost, and this (subpersonal) opportunity-cost estimation is reflected (at the personal level) in the feeling of effort that accompanies the selected action. Such action feels increasingly effortful as its opportunity cost mounts. Thus, the feeling of effort guides us to disengage from actions as other, more valuable alternatives become salient.

Another kind of choice-based theory views the feeling of effort as helping agents navigate the tradeoff between valuable but mutually exclusive modes of information processing. Consider the tradeoff between *cognitive flexibility* and *cognitive stability* (Musslick & Cohen, 2021). Allocating our cognitive resources (like working memory and attention) to a single task increases the accessibility of task-relevant information, while inhibiting task-irrelevant information. This stable and narrow processing mode is useful for solving complex tasks, but task-irrelevant information can still be important for other goals, and ignoring it implies risks. (Excessive focus on my Sudoku can make me ignore the smell of gas coming from the kitchen.) Thus, too much stability can lead to rigidity. This highlights the value of cognitive flexibility, which allows us to switch between tasks more easily, but in turn implies we may lose the benefits of completing complex tasks that require sustained attention. According to this *optimality account*, the feeling of effort helps us navigate the stability-flexibility tradeoff by guiding us away from excessively stable information-processing modes, and toward increasing flexibility.

These are two of many possible choice-based accounts (e.g. Berkman et al., 2017; Navon, 1989). Seen independently, each account has strengths and drawbacks. Opportunity-cost accounts could unify the phenomenology of effort in both mental and bodily action, by appealing to a general-purpose cost-benefit calculator for both mental and physical costs (Bermúdez, 2022). Supportive

evidence comes from studies suggesting a large overlap in brain areas underlying expected-cost calculations for both mental and physical actions (Chong et al., 2017). But several issues remain, one among them being that to guide action choice, the cost-benefit calculator should estimate the expected costs of actions that the agent is not currently performing. The feelings corresponding to these cost estimations cannot be feelings of effort, since the feeling of effort is 'existentially committing': as opposed to feelings like fear (where the object of the feeling may exist or not), the experience of effort seems to always represent existing actions as occurrent (actions are felt as effortful only while they are performed).

For their part, optimality theories respect the feeling of effort's existentially committing character, may be unable to unify mental and non-mental efforts, since their explanation is entirely based on the functioning of cognitive mechanisms. That said, these theories are not incompatible, and could be integrated into a unified perspective.

3. The Relations between Effort and the Feeling of Effort

Having surveyed the main theories of effort and of the feeling of effort, how should we understand the relation between efforts and their feelings? Astonishingly, this question is rarely ever raised. To move forward on the issue we discuss two main paths toward an answer.

3.1. Representationalism and the Effort-First Approach

Representationalism states that the feeling of effort represents efforts. According to representationalism, the 'of' in 'feeling of effort' is intentional or representational, so that the feeling of effort is about effort, in the same way that the hearing of sounds is about sounds (Brogaard, 2012). Varieties of representationalism may be distinguished, first, depending on how the representation is construed: as a perception, a judgment, a proprioceptive state, an affective state… Second, one may distinguish *strong representationalism*, the view that the feeling of effort just is a representation of effort, from *weak representationalism*, the view that the feeling of effort is a representation of effort together with additional non-representational properties.

Resource-based, force-based, and mediation accounts are easily conjoined with representationalism. If efforts are goal-directed resource consumptions, force exertions, or intensifications of activity, then feelings effort would just be representations of those goal-directed resource-consumptions, force exertions, and activity intensifications, respectively. Likewise, centralist and peripheralist accounts of the feeling of effort, conjoined with representationalism, trivially yield corresponding accounts of effort. If the feeling of effort is the representation of a command of the will, then efforts would be commands of the will; and if the feeling of effort is the representation of muscle

contractions, then efforts would just be muscle contractions. All of these would be *effort-first views*: they would define the feeling of effort by reference to the nature of effort itself.

In contrast, comparator and choice-based accounts of the feeling of effort are harder to combine with representationalism because they do not conceive of these feelings as representations: rather, they describe such feelings functionally as playing the role of influencing action execution or action selection. Such accounts are thus more congenial to *anti-representationalism*, the view that feelings of effort do not represent efforts.

Among the possible effort-first accounts, a force-based approach seems most promising, partly because it allows for a direct explanation of why the feeling of effort involves the experience of countering a resistance. As discussed above (§1.1), a force-based account can explain non-physical efforts by providing a formal account of forces and can explain the difficulty of efforts as a property supervening on both the exerted force's intensity and the agent's capacities (Massin, 2022). Accounting for feelings of effort by reference to efforts raises two challenges for this theory. The first is to ensure that effort, described in terms of exerted forces is not too complex to be "feelable". In particular, while the perception of muscular force is well-documented, the experience of mental forces (e.g., temptations and the forces we exert to resist them) remains largely unexplored. Second, the resolutely objectivist orientation of the force-based account, which views both efforts and their difficulty as being independent from experience, may be found counterintuitive by those who tend to think of effort or of its difficulty as pain-like phenomena whose mere existence involves an experience.

3.2. Anti-Representationalism and the Feeling-First Approach

Anti-representationalism is the view that feelings of effort do not represent efforts. A radical anti-representationalist approach states that feelings of effort are mere qualia and represent nothing at all. Doulatova (2021) has defended such a view regarding feelings of mental effort, arguing that they do not systematically track any aspect of an agent's environment, actions, or inner processes. If correct, this puts pressure on attempts to naturalize phenomenology by claiming experiences track features of one's environment.

Anti-representationalists can, however, also defend a systematic, albeit non-representational, relationship between efforts and their feelings. *Feeling-first approaches* propose that efforts must be defined by reference to feelings of effort. Bermúdez (2022) argues for a feeling-first approach, defining efforts as actions that are accompanied by an experience of effort.[5] The feeling-first approach could be combined with any substantive theory of the feeling of effort to produce specific

[5] A precedent for this move was set by Shepherd (2016), who argues that the feeling of trying is partly constitutive of the nature of actual tryings.

definitions of effort. Thus, combined with e.g. the comparator account, a feeling-first approach would characterize efforts as actions whose performance is accompanied with, or requires reducing, prediction-error signals.

If efforts indeed have a common feel, a feeling-first account can straightforwardly unify all kinds of efforts (bodily, mental, and beyond) by reference to their phenomenology, thereby sidestepping the thorny ontological issues representationalist views must face. But a feeling-first account faces its own problems. One challenge, reminiscent of the so-called heterogeneity problem in the philosophical literature on pleasure, is to bring out what all feelings of effort (bodily, mental, etc.) have common without relying on the representational contents of those feelings. Adopting a choice-based approach, Bermúdez (2022) proposes that this unifying feature is the role they play in guiding action selection: they motivate agents to disengage from the current action. A second problem is this. Suppose Bob is carrying a heavy bag from the store to his house and starts experiencing a feeling of effort only 90 seconds into the action. The feeling-first approach entails that Bob started his effort only when he started feeling effort, at the 90th second. This sounds odd. Effort-first theorists, by contrast, identify the beginning of the effort with the beginning of the action. A refined feeling-first account may however accommodate that consequence as follows. The feeling of effort faces the agent with a choice whether to continue the action, and this action becomes an effort only if the agent chooses to continue it despite the feeling. On this refined position, an effort is an action that not just feels effortful but is also pursued despite feeling effortful. If correct, the view that Bob starts his effort only after he begins feeling effort may not be a reductio after all.

4. Conclusion

In this review we have surveyed the main theories of effort, the feeling of effort, and the relation between the two. Two key takeaways emerge. First, there is widespread agreement that efforts are identical to goal-directed actions, and, since feelings are different from actions, researchers should clearly distinguish efforts from feelings of effort. Second, one of the main philosophical issues to be decided is whether feelings of effort should be defined by reference to efforts (effort-first approach), or whether efforts are defined by reference to the feeling of effort (feeling-first approach). By charting the main strengths and weaknesses of each alternative, we hope to contribute to moving the discussion forward.

Acknowledgments

This work was supported by the Swiss National Science Foundation (grant #170456). We would like to thank a reviewer for this journal and the section editor for their helpful comments. Our gratitude also to Guido Gendolla, Joshua Shepherd, Benjamin Pageaux, Kathrin Koslicki, Simon-Pierre Cheverie-Cossette, and all the members of the Neuchâtel philosophy writing seminar for detailed and insightful comments to previous versions of this paper.

References

Baumeister, R. F., Muraven, M., & Tice, D. M. (2000). Ego depletion: A resource model of volition, self-regulation, and controlled processing. *Social Cognition*, *18*(2), 130–150.

Bayne, T. (2011). The sense of agency. In F. McPherson (Ed.), *The senses*. Oxford University Press.

Bayne, T., & Levy, N. (2006). The feeling of doing: Deconstructing the phenomenology of agency. In N. Sebanz & W. Prinz (Eds.), *Disorders of volition* (pp. 49–68). MIT Press.

Bergevin, M., Steele, J., Payen de la Garanderie, M., Feral-Basin, C., Marcora, S. M., Rainville, P., Caron, J. G., & Pageaux, B. (2021). Pharmacological blockade of muscle afferents and perception of effort: A systematic review with meta-analysis. *BioRxiv*. https://doi.org/10.1101/2021.12.23.474027

Berkman, E. T., Hutcherson, C. A., Livingston, J. L., Kahn, L. E., & Inzlicht, M. (2017). Self-control as value-based choice. *Current Directions in Psychological Science*, *26*(5), 422–428.

Bermúdez, J. P. (2017). Do we reflect while performing skillful actions? Automaticity, control, and the perils of distraction. *Philosophical Psychology*, *30*(7), 896–924. https://doi.org/10.1080/09515089.2017.1325457

Bermúdez, J. P. (2022). *What is the feeling of effort about?* PsyArXiv. https://doi.org/10.31234/osf.io/wr7b8

Blakemore, S.-J., Wolpert, D. M., & Frith, C. D. (2002). Abnormalities in the awareness of action. *Trends in Cognitive Sciences*, *6*(6), 237–242.

Bradford, G. (2013). The value of achievements. *Pacific Philosophical Quarterly*, *94*(2), 204–224. https://doi.org/10.1111/j.1468-0114.2012.01452.x

Brehm, J. W., & Self, E. A. (1989). The intensity of motivation. *Annual Review of Psychology*, *40*, 109–131. https://doi.org/10.1146/annurev.psych.40.1.109

Brogaard, B. (2012). What do we say when we say how or what we feel? *Philosophers Imprint*, *12*.

Carter, E. C., & McCullough, M. E. (2014). Publication bias and the limited strength model of self-control: Has the evidence for ego depletion been overestimated? *Frontiers in Psychology*, *5*, 1–11.

Chong, T. T. J., Apps, M., Giehl, K., Sillence, A., Grima, L. L., & Husain, M. (2017). Neurocomputational mechanisms underlying subjective valuation of effort costs. *PLoS Biology*, *15*(2), 1–28.

Dang, J. (2016). Testing the role of glucose in self-control: A meta-analysis. *Appetite*, *107*, 222–230.

de Vignemont, F., & Massin, O. (2015). Touch. In M. Matthen (Ed.), *The Oxford handbook of the philosophy of perception* (pp. 294–313). Oxford University Press.

Destutt de Tracy, A. (1801). *Projet d'éléments d'idéologie à l'usage des écoles centrales de la République française [Project of Elements of Ideology]*. Pierre Didot l'aîné, Firmin Didot et Debray.

Dilthey, W. (2010). The origin of our belief in the reality of the external world and its justification. In R. A. Makkreel & F. Rodi (Eds.), *Selected Works: Vol. II: Understanding the Human World* (pp. 8–57). Princeton University Press.

Feynman, R. P. (1964). The Feynman lectures on physics. *Physics Today*, *17*(8), 45.

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives*, *19*(4), 25–42. https://doi.org/10.1257/089533005775196732

Friese, M., Loschelder, D. D., Gieseler, K., Frankenbach, J., & Inzlicht, M. (2018). Is ego depletion real? An analysis of arguments. *Personality and Social Psychology Review*.

Frith, C. (2012). Explaining delusions of control: The comparator model 20 years on. *Consciousness and Cognition*, *21*(1), 52–54.

Gailliot, M. T., & Baumeister, R. F. (2007). The physiology of willpower: Linking blood glucose to self-control. *Personality and Social Psychology Review*, *11*(4), 303–327. https://doi.org/10.1177/1088868307303030

Gailliot, M. T., Baumeister, R. F., Dewall, C. N., Maner, J. K., Plant, E. A., Tice, D. M., Brewer, L. E., & Schmeichel, B. J. (2007). Self-control relies on glucose as a limited energy source: Willpower is more than a metaphor. *Journal of Personality and Social Psychology*, *92*(2), 325–336. https://doi.org/10.1037/0022-3514.92.2.325

Gendolla, G. H. E., & Wright, R. A. (2009). Effort. In D. Sander & K. R. Scherer (Eds.), *The Oxford companion to emotion and the affective sciences* (pp. 134–135). Oxford University Press.

Gendolla, G. H. E., Wright, R. A., & Richter, M. (2019). Advancing Issues in Motivation Intensity Research: Updated Insights from the Cardiovascular System. In R. M. Ryan & R. M. Ryan (Eds.), *The Oxford Handbook of Human Motivation* (2nd ed., pp. 372–392). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190666453.013.21

Haggard, P. (2005). Conscious intention and motor cognition. *Trends in Cognitive Sciences*, *9*(6), 290–295. https://doi.org/10.1016/j.tics.2005.04.012

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin*, *136*(4), 495–525.

Helmholtz, H. V. (1866). *Handbuch der physiologischen Optik [Treatise on physiological optics]*. Voss.

Holton, R. (2009). *Willing, wanting, waiting*. Oxford University Press.

Hull, C. L. (1943). *Principles of behavior* (Vol. 422). Appleton-century-crofts New York.

Inzlicht, M., Shenhav, A., & Olivola, C. Y. (2018). The effort paradox: Effort is both costly and valued. *Trends in Cognitive Sciences*, *22*(4), 337–349. https://doi.org/10.1016/j.tics.2018.01.007

James, W. (1880). *The feeling of effort*. The Society of Natural History.

Jeannerod, M. (1983). *Le cerveau-machine: Physiologie de la volonté*. Fayard.

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

Kool, W., & Botvinick, M. (2018). Mental labour. *Nature Human Behaviour*, *2*(12), 899–908.

Kool, W., McGuire, J. T., Rosen, Z. B., & Botvinick, M. (2010). Decision making and the avoidance of cognitive demand. *Journal of Experimental Psychology: General*, *139*(4), 665–682.

Kruglanski, A. W., Bélanger, J. J., Chen, X., Köpetz, C., Pierro, A., & Mannetti, L. (2012). The energetics of motivated cognition: A force-field analysis. *Psychological Review*, *119*(1), 1–20. https://doi.org/10.1037/a0025488

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*(1), 313–321. https://doi.org/10.1152/jn.00027.2010

Kurzban, R., Duckworth, A., Kable, J. W., & Myers, J. (2013). An opportunity cost model of subjective effort and task performance. *Behavioral and Brain Sciences*, *36*(06), 661–679.

Lafargue, G., & Franck, N. (2009). Effort awareness and sense of volition in schizophrenia. *Consciousness and Cognition*, *18*(1), 277–289. https://doi.org/10.1016/j.concog.2008.05.004

Levy, N. (2011). Resisting "weakness of the will." *Philosophy and Phenomenological Research*, *82*(1), 134–155.

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

Lukitsch, O. (2020). Effort, uncertainty, and the sense of agency. *Review of Philosophy and Psychology*.

Maine de Biran, P. (2000). Nouvelles considérations sur les rapports du physique et du moral (1820) [New considerations on the relations between the physical and the moral]. In *Œuvres complètes: Vol. IX*. Vrin.

Maine de Biran, P. (2002). Essai sur les fondements de la psychologie [Essay on the Foundations of Psychology]. In *Œuvres completes: Vol. VII–1*. Vrin.

Massin, O. (2017). Towards a definition of efforts. *Motivation Science*, *3*(3), 230–259. https://doi.org/10.1037/mot0000066

Massin, O. (2022). *Defining physical efforts*. PsyArXiv. https://doi.org/10.31234/osf.io/qmg5j

Musslick, S., & Cohen, J. D. (2021). Rationalizing constraints on the capacity for cognitive control. *Trends in Cognitive Sciences*, *25*(9), 757–775.

Navon, D. (1989). The importance of being visible: On the role of attention in a mind viewed as an anarchic intelligence system 1. Basic tenets. *European Journal of Cognitive Psychology*, *1*(3), 191–213. https://doi.org/10.1080/09541448908403081

Pacherie, E. (2008). The phenomenology of action: A conceptual framework. *Cognition*, *107*(1), 179–217.

Pageaux, B. (2016). Perception of effort in exercise science: Definition, measurement and perspectives. *European Journal of Sport Science*, *16*(8), 885–894. https://doi.org/10.1080/17461391.2016.1188992

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

Peirce, C. S. (1935). *Collected papers of Charles Sanders Peirce* (C. Hartshorne & P. Weiss, Eds.; Vol. 5). Harvard University Press.

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

Preston, J., & Wegner, D. M. (2009). Elbow grease: When action feels like work. *Oxford Handbook of Human Action*, 569–586.

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*(2).

Shenhav, A., Musslick, S., Lieder, F., Kool, W., Griffiths, T. L., Cohen, J. D., & Botvinick, M. M. (2017). Toward a rational and mechanistic account of mental effort. *Annual Review of Neuroscience*, *40*(1), 99–124.

Shepherd, J. (2016). Conscious action/zombie action. *Nous*, *50*(2), 419–444.

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

Silvestrini, N., Musslick, S., Berry, A. S., & Vassena, E. (2021). An integrative effort: Bridging motivational intensity theory and recent neurocomputational and neuronal models of effort and control allocation. *Psychological Review*. https://doi.org/10.31234/osf.io/gn37y

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*. https://doi.org/10.31234/osf.io/kbyhm

Stout, G. F. (1931). *Mind and matter*. Cambridge University Press.

Székely, M., & Michael, J. (2021). The sense of effort: A cost-benefit theory of the phenomenology of mental effort. *Review of Philosophy and Psychology*, *12*, 889–904. https://doi.org/10.1007/s13164-020-00512-7

Szwed, P., Kossowska, M., & Bukowski, M. (2021). Effort investment in uncontrollable situations: The moderating role of motivation toward closure. *Motivation and Emotion*, *45*(2), 186–196. https://doi.org/10.1007/s11031-021-09868-4

Taylor, S. E. (1981). The interface of cognitive and social psychology. *Cognition, Social Behavior, and the Environment*, *1*, 189–211.

Vadillo, M. A., Gold, N., & Osman, M. (2016). The bitter truth about sugar and willpower: The limited evidential value of the glucose model of ego depletion. *Psychological Science*, *27*(9), 1207–1214. https://doi.org/10.1177/0956797616654911

Vohs, K. D., Schmeichel, B. J., Lohmann, S., Gronau, Q. F., Finley, A. J., Ainsworth, S. E., Alquist, J. L., Baker, M. D., Brizi, A., Bunyi, A., Butschek, G. J., Campbell, C., Capaldi, J., Cau, C., Chambers, H., Chatzisarantis, N. L. D., Christensen, W. J., Clay, S. L., Curtis, J., & Cristofaro, V. D. (2021). A multisite preregistered paradigmatic test of the ego-depletion effect. *Psychological Science*, *32*(10), 1566–1581.

Von Holst, E., & Mittelstaedt, H. (1950). Das Reafferenzprinzip [The reafference principle]. *Naturwissenschaften*, *37*(20), 464–476.

von Kriegstein, H. (2017). Effort and achievement. *Utilitas*, *29*(1), 27–51. https://doi.org/10.1017/S0953820816000170

Westbrook, A., & Braver, T. S. (2013). The economics of cognitive effort. *Behavioral and Brain Sciences*, *36*(6), 704–705.

Westbrook, A., Kester, D., & Braver, T. S. (2013). What is the subjective cost of cognitive effort? Load, trait, and aging effects revealed by economic preference. *PLoS ONE*, *8*(7), 1–8.

Wright, R. A. (2016). Motivation theory essentials: Understanding motives and their conversion into effortful goal pursuit. *Motivation and Emotion*, *40*(1), 16–21.

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