The Cognitive Control Account of Effort

(9517 words excluding bibliography, 1117 including bibliography)

At first glance, the type of effort required to solve a chess puzzle and run a marathon seem fundamentally different. I argue that they're not. I present a novel account of effort in which all effort is explained in terms of a domain-general psychological mechanism, cognitive control. I outline how effort choice and execution take place, emphasizing the role of cognitive control, a mental process by which all effort –mental and bodily– is made. I present four arguments that convergently provide strong support for the cognitive control account. Additionally, I examine the implications of this unified theory of effort for philosophical discussions in ethics, philosophy of mind, and action theory.

Keywords: Effort, Difficulty, Trying, Achievement

Introduction

Suppose you were to move some furniture across the room and then try to name the first fifteen prime numbers. Both are efforts you choose to make. But they seem strikingly different. One requires movement and force, and the other requires intellectual focus and persistence. Both would be called 'effortful' as they involve feelings of effort – yet the respective feelings are different. What, if anything, makes both effort?

Over the last few years, the debate over the nature of effort has picked up steam (Bradford, 2015; Massin, 2017, 2024; Lukitsch, 2020; Bermúdez & Massin, 2023; Shepherd, 2023; Bermúdez, 2024; Wolpe, Holton & Fletcher, 2024; Ziff, 2024), partly motivated by various ethical debates making liberal use of the concept (Bradford, 2013, 2015, 2016, 2017; Nelkin, 2016; Guerrero, 2017; von Kriegstein, 2019; van Ackeren, 2018; Chappell, 2019; Hirji, 2019; McElwee, 2022; Kieval 2024). For example, effort has been invoked to explain the value of achievement (Bradford, 2015; von Kriegstein, 2017), the nature of moral demands (Chappell, 2019; McElwee, 2022), and the architecture of action selection (Bermudez, 2023). Often, philosophers invoke effort because of the connection between effort and the will(power) involved in making an effort. Each of these uses of the concept of effort in philosophy span both the mental and the bodily domain: Chess championships and weightlifting championships are both considered outstanding achievements, for example. But the dissimilarity of these activities illustrates a pressing concern identified in the literature on effort, which is that very different activities are considered as instances of effort. Is

effort a unified phenomenon or are different explanations needed for mental and bodily effort? Call this the *unification question*.

Given recent advances in our philosophical and psychological understanding of effort and cognate phenomena, the time is ripe to answer the unification question. In this paper, I argue that effort is indeed unified, because all effort is explained by a shared, domain-general cognitive architecture.

The cognitive control account centers around the interaction of two psychological mechanisms: expected value of control (EVC) and the cognitive control system. We will delve into them further in the following sections. In simple terms, EVC assesses the value of potential effort and identifies the most valuable effort available to the agent. It then transmits a signal to the cognitive control system, the second mechanism, which carries out the specific task.

It is widely believed among cognitive scientists, neuroscientists, and psychologists that to make a mental effort is to deploy cognitive control (cf. Shenhav et al., 2013; Kurzban et al., 2013; Badre, 2025). How this relates to bodily effort is much less clear. A few scientists implicitly or explicitly assume cognitive control might explain bodily effort, but this claim is rarely argued for (cf. Kurzban, 2016; Badre, 2025). Indeed, it is exceedingly rare for bodily effort to be discussed explicitly in the cognitive control literature. The opposite is true for a kindred debate in kinesiology, which discusses bodily effort at length, but ignores mental effort (cf. Pageaux, 2016; Bergevin et. al, 2021). These two literatures rarely interact: I synthesize them in this article.

A chief novelty of this paper is to combine psychological, kinesiological and philosophical insights that are currently siloed to provide a novel, coherent, unified account of effort. The picture that emerges from an interdisciplinary look at effort puts cognitive control at the center of all effort. Put concisely, I argue that a goal-directed deployment of cognitive control is necessary and sufficient for mental effort. Such a cognitive control deployment (and thereby, a mental effort) is also a necessary component of bodily effort. But it is not sufficient: the cognitive control deployment needs to issue central motor commands for the effort to be a bodily effort. In both cases, the features most characteristic of our efforts, such as their voluntary and agentic characteristics, arise from the involvement of cognitive control. We will add details to this picture soon.

The philosophical innovations of this project are manifold. First, I present the first philosophical defense of a cognitive control account of effort, applying results from cognitive science and kinesiology to philosophical debates about effort. Second, I generalize cognitive control accounts, which are commonly invoked for mental effort, to bodily effort. As we will see, this generalization uniquely captures central features of effort that the philosophical literature has identified, such as effort choice, control and the relationship of effort and skill. It also makes progress in cognate debates concerning difficulty, achievement, moral responsibility, non-human effort and action theory.

The paper has five parts. The first introduces several contemporary views on effort and presents arguments against them. The second elaborates on existing domain-specific cognitive control views, setting the stage for my account. The third section introduces the novel domain-general cognitive control account of effort and provides four arguments in its favor. The fourth section revisits existing views on effort to discuss their merits relative to the cognitive control view. The fifth and final section explains why philosophers should care about unifying effort, demonstrating how a unified account of bodily and mental effort enables genuine progress on long-standing philosophical problems. My account has broad implications for various ongoing debates in philosophy of mind, action, and ethics.

1. Current Accounts of Effort

There are four prominent views on effort. Feeling-first views take effort to be action accompanied by feelings of effort (Bermudez, 2024; Wolpe, Holton & Fletcher, 2024). Resource views define effort as the expenditure of a depletable resource (Baumeister et al., 2007). Resistance views see effort as the overcoming of a resistive force (Massin, 2017; Massin, 2024; Holton & Holton, forthcoming). Cognitive control views understand effort as the deployment of the psychological mechanism of cognitive control (Kurzban et al., 2013; Shenhav et al., 2013; Shenhav & Botvinick, 2019). All of these views currently face significant problems.

Feeling-first views explain effort as action accompanied by a feeling of effort. While the feelings of bodily and mental effort are distinct, they share a function: they help us decide which effort to perform, as we will see shortly. This shared function of guiding effort choice, Bermudez (2024) argues, unifies effort. The main problem faced by feeling-first views is that effort and feelings of effort are dissociable. Stroke patients who have lost the capacity to feel effort (Naccache, 2005), athletes entering flow states of complete absorption in a task that feel effortless (Csikszentmihalyi,

2002), or a small everyday effort like making an effort to cheer up a friend provide apparent examples of individuals making an effort without experiencing a feeling of effort (Bermudez & Massin, 2023). Counterexamples to feeling-first views abound.

Resource-based views take effort to be the expenditure of a depletable biological resource (typically, glucose) to control our behavior and the feeling of effort to signal how much of the resource remains. These accounts center around the phenomenon of Ego Depletion, i.e., the observation that acts of self-control (paradigm cases of effort) decrease future task performance. However, the empirical tide has turned significantly against these views. After a series of elaborate, preregistered large-scale replication studies failed to detect Ego Depletion effects, the once-dominant resource-based accounts have fallen from favor (Carter et al., 2015; Vohs et al., 2021).[1]

Resistance views take effort to be the exertion of force to overcome a resistant force. Massin presents the contemporary case (2017, 2024) for these historically influential views. Resistance views explain bodily effort particularly well but lack an explanation of mental effort. Current accounts restrict themselves to analyzing bodily effort, because physical forces are well-understood, but mental forces are not. But this leads to problems even in the bodily domain. Consider a dancer learning a new routine. The force required to dance the routine remains unchanged, as does the dancer's capacity to exert it. Yet as he becomes more skillful at the new routine, dancing becomes less effortful. A plausible response may claim that dancing is not a purely bodily effort, but a mixed effort: following the routine requires mental effort as well, and it is this mental effort that is eased with practice. But how could resistance views explain mental effort? Presumably, this would require a concept of mental force, and current resistance views offer no such account. What force does the dancer's mind exert? What force resists the dancer's will? The problem is even more pressing for purely mental effort. Reading the *Tractatus* requires great effort. However, what mental force is exerted or resisted here? That of the forcefully-written text? That of the defiant Austrian firebrand philosopher? We will revisit these issues later.

Lastly, cognitive control views take effort to be the deployment of cognitive control, a specific psychological mechanism (Carruthers & Williams, 2022). These views have strong empirical support and are widely accepted in cognitive science (Kurzban et al., 2013; Shenhav et al., 2013,

[1] Self-control is now typically understood as a limited, but non-depletable capacity (like RAM), rather than as a depletable resource (like oil), as I discuss in more detail below.

2017, 2021) but haven't made their way into the philosophical mainstream yet.[2] However, as their name suggests, these views are thoroughly cognitive. Their highly predictive models are typically studied on paradigmatically mental tasks that test for memory, attention or mental suppression. While some cognitive scientists assume these results transfer to all behavior, arguments for this assumption are sparse and lack empirical detail and theoretical justification. Like resistance views, current cognitive control views are too domain-specific to answer the unification question, remaining silent on what it is to make a bodily effort.[3] This paper changes this.

I now will draw on cognitive control views to provide a domain-general theory of effort. I will argue that philosophers and cognitive scientists alike have failed to recognize that we have the resources to explain *all* effort – including bodily effort. My account combines three currently isolated bodies of research: research on bodily effort from kinesiology, research on mental effort from neuroscience and computational psychology, and a set of philosophical intuitions regarding the deep connections between mental and bodily effort. I will argue that cognitive control is necessary to bodily effort. Furthermore, I will argue that cognitive control is more than a mere causal antecedent of bodily effort, both because it cannot be causally substituted and because it explains the central features of effort choice, control and skill that other philosophers have identified as essential to effort. Before fleshing out this proposal, it will be helpful to add a bit more detail on the psychological mechanisms involved.

2. Cognitive Control Views

Cognitive control views explain mental effort through the interplay between two psychological mechanisms: Expected Value of Control (EVC) and the cognitive control system. In simple terms, EVC assesses the value of different potential uses of cognitive control. A signal indicating the option with the highest value is then sent to the cognitive control system ('effort choice'), resulting in the appropriate use of cognitive control ('mental effort'). The EVC associated with the current use of cognitive control triggers an aversive feeling, which becomes stronger as the EVC decreases. This is the feeling of mental effort. Let us delve a bit deeper into both of these mechanisms.

[2] Welcome exceptions are Bermudez & Massin (2024) and Shepherd (2024), both of which discuss cognitive control views without embracing them.

[3] This paper provides a solid justification for the narrow claim that cognitive control is essential to bodily effort by integrating research on cognitive control with results from kinesiology and philosophy that currently remain overlooked by cognitive control research. The broader question of how cognitive control relates to action is addressed in Buehler (2018, 2023), Sripada (2020, 2025), Wu (2023), Bianchi (2025) and (redacted). I thank a reviewer for thoughtful commentary on this dialectic.

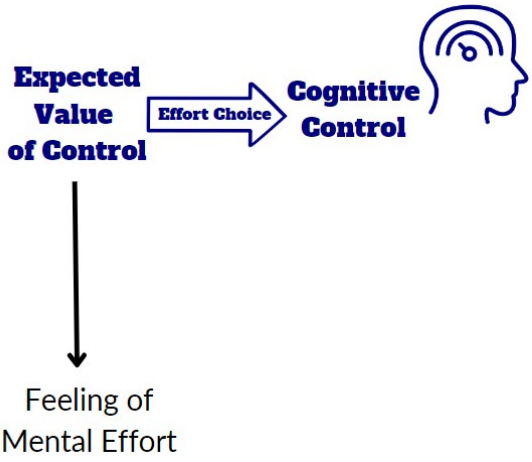

Figure 1: Mental Effort

Effort reward and effort cost jointly determine the expected value of control. The expected value of control generates a feeling of mental effort as well as an effort choice[4] (decision). The effort choice determines the deployment of cognitive control, which constitutes a mental effort.

Cognitive control, sometimes called executive function, is a high-level control process that enables flexible, voluntary selection, maintenance and adjustment of behavior. The difference between these voluntarily deployed, context-sensitive cognitive control processes and the passive, involuntarily deployed, context-insensitive automatic processes is a key focus in modern cognitive science, and a solid body of evidence for this distinction has accumulated over the last two decades.[5]

To understand the distinction, consider various behaviors such as pupil dilation, reading, or mental math. Some behaviors, such as pupil dilation, are entirely regulated by inflexible automatic processes and can only be indirectly affected, for example, by turning off the light. Other behaviors, like complex math calculations, require more flexible, deliberate high-level cognitive control, including holding your goal in mind, suppressing mind-wandering or movement, and performing sequential operations on high-level representations. These latter processes enable a more direct, top-down form of control. Cognitive control is deployed in a domain-general fashion

[4] In folk parlance, decisions sometimes pick out complex, step-by-step episodes of conscious reasoning, such as when weighing different factors in which school to attend. By contrast, the way the authors referred to here and I use the word 'effort choice' is as a basic value-based decision of a subpersonal sort: brief mental events that unfold over a mere fraction of a second. They are typically taken to be the building blocks that more complex decisions and behaviors composed of. See Sripada (2025) for a more complete discussion of the decisional architecture in human agency.

[5] Central works include Fitts, 1964; Shiffrin & Schneider, 1977; D'esposito et al., 1995; Kahneman, 2011; Diamond, 2013. Buehler 2018 and Badre (2025) provide the go-to analysis of cognitive control processes from a philosophical and psychological perspective, respectively.

and is primarily associated with activity in the prefrontal cortex (PFC) (Koechlin et al., 2003; Levy, 2024).

It's much easier to intuitively grasp the distinction between automatic and cognitively controlled processes than it is to delineate them cleanly (Shepherd, 2023; Buehler, forthcoming). Part of the issue is that most activities involve both. Consider reading a philosophy paper. Word processing relies on highly automatized habits, whereas deciding which aspects you jot down into your notebook involves higher-order cognitive control. But there is a clear difference between these processes. For example, you cannot help but visually process the stop sign on the road as a red sign saying 'stop'. This is because visual processing is automatic. But you can ignore the stop sign – this is because driving is not automatic but involves cognitive control. The fact that cognitive control processes seem to be goal-sensitive, flexible and controlled leads many philosophers to believe they may be a key to understanding agency (cf. Footnote 3). We will return to this later.

The capacity to deploy cognitive control to tasks is limited. Capacity limitations can arise from various factors. This includes more permanent factors like working memory capacity, computational, and architectural constraints; as well as fluctuating factors such as sleep, metabolic constraints, and the tendency of parallel tasks to interfere with each other's processing (Engle, 2002; Musslick et al., 2019). The relative importance of such factors in limiting our capacity to deploy cognitive control is still in question. However, that capacity limitations exist is beyond doubt (Musslick & Cohen, 2021).

Given this capacity limitation, it's necessary to prioritize between different ways of distributing cognitive control capacity. Decisions about how to utilize cognitive control are made by the EVC mechanism, which is associated with structures in the dorsal anterior cingulate cortex (dACC). This mechanism integrates three factors: effort cost, effort efficacy, and expected reward (Kurzban et al., 2013; Shenhav et al., 2013, 2017, 2021).

Deploying cognitive control is costly (Westbrook et al., 2013), both intrinsically and because it incurs an opportunity cost (Kurzban et. al, 2013). Cognitive control spent on one task cannot be devoted to other tasks. Deploying more cognitive control to a task often increases our chances of success at that task. For example, fully focusing on difficult math homework greatly enhances my chances of success. Fully focusing on how I type on my keyboard only improves performance marginally, as high reliability can be achieved with very little cognitive control. The degree to which

an increase in cognitive control increases our chances of success is called *effort efficacy*. An expected value of deploying cognitive control is generated by combining these factors of effort cost, task outcome value, and effort efficacy.

This model explains the feeling of mental effort, which serves to facilitate task-switching. Specifically, the value generated by EVC is inversely proportional to the intensity of the feeling of effort. Engaging with a task that carries an extremely high expected value but requires only a fraction of one's cognitive control capacity will feel almost effortless. In contrast, a task that carries a low expected value but requires a high deployment of cognitive control will feel effortful. Modulate effort cost, outcome value, or effort efficacy, and the (typically aversive) feeling of mental effort will change. Consequently, we often choose to shift our effort away from the low-expected-value tasks that feel more effortful, such as doing homework, and towards the high-expected-value tasks that feel less effortful, such as watching an exciting new TV series (Kurzban, 2016; Bermudez, 2024). The highest-value option EVC identifies is signaled to PFC to initiate the appropriate effort (*effort choice*). This is how decisions about how to deploy cognitive control arise from the EVC mechanism.

This model of EVC, effort choice and cognitive control/mental effort provides the following picture of (mental) effort:

> **Mental Effort:** Making a mental effort is a goal-directed deployment of cognitive control. A mental effort's strength is proportional to the degree to which cognitive control is deployed.

The view of mental effort presented here has widespread support in cognitive science (Westbrook et al., 2013; Kurzban et al., 2013; Shenhav et al., 2013; 2017; 2021). However, the view seems highly specific to mental effort and, therefore, ill-suited for a general explanation of effort. What about bodily effort?

The rest of this paper leverages new empirical and philosophical arguments to unify mental and bodily effort. To appreciate this new view, our perspective on how different types of effort relate must change. I argue for this novel view: that mental and bodily effort are not two independent ways of engaging the world. Instead, cognitive control/mental effort lies at the heart of all effort. On

this view, when we use cognitive control to issue central motor commands, a bodily effort ensues. The following section, which is the heart of the paper, will now argue at length for this view.

3. The Cognitive Control View of Effort

Before clarifying the relationship of mental and bodily effort, let's review and define bodily effort. An exciting set of recent experiments in kinesiology has shown the feeling of bodily effort to be caused by a *central motor command*. Central motor command is a technical term introduced by kinesiologists for the characteristic patterns of neural activation that initiate *voluntary controlled movement* (Lafargue et al., 2003; Pageaux, 2018; Bergevin et al., 2021; Marcora et al., 2023; early roots for this view can be traced to Helmholtz, 1867).

This result is important because it provides a link between cognitive control and bodily effort. It was previously believed that the feeling of bodily effort may arise from a mismatch between predictions of limb trajectories and afferent feedback on actual limb position. This left the connection between the feelings of mental and bodily effort unclear. Why would errors in predicting limb position regulate effort choice? How would they be related to cognitive control, and thereby, mental effort? Central motor commands, however, are intimately tied to effort choice and cognitive control, as I'll show. Combining results from kinesiology and cognitive control research will give us a solid empirical foundation for a novel, unified analysis of effort in terms of cognitive control.

Remember that the feeling of mental effort serves the function of prioritizing high-value over low-value tasks. The same is true for the feeling of bodily effort (Kurzban, 2016; Pageaux, 2016; Bermudez, 2024), which is an aversive feeling that inclines us to abandon movements that hold little value at significant cost. The feeling of bodily effort arises as a phenomenological upshot from central motor commands, which initiate and sustain voluntary movement (Bergevin et al, 2021). This insight is crucial to explaining the functionally similar roles of both feelings of effort: cognitive control enables voluntary mental behavior, and central motor command enables voluntary bodily behavior. The feelings of mental and bodily effort are thus believed to play a vital role in regulating voluntary, controlled behavior in their respective domain by providing information about the value of our current effort. Using these insights, we can propose the following novel view of bodily effort:

> **Bodily Effort**: Making a bodily effort is a goal-directed deployment of cognitive control that issues central motor commands.

How do mental and bodily effort relate? The cognitive control view of effort posits a necessary role for cognitive control/mental effort in the explanation of bodily effort. It denies that mental and bodily effort are identical. A deployment of cognitive control that does not issue central motor commands is not a bodily effort, but is a purely mental effort. It also denies that the role of cognitive control in bodily effort is merely that of a causal antecedent, as we will see.

I will first introduce a set of subtraction arguments to show that cognitive control's role in bodily effort is more than causal. When central motor commands are triggered by alternative causes, the result is not bodily effort. I will further argue that mental and bodily effort are not identical, because their relationship is asymmetrical: all bodily effort involves mental effort, but not all mental effort involves bodily effort. After having clarified the relationship of mental and bodily effort, I will argue that essential features of effort that have been identified in the philosophical literature are in fact explained by the involvement of cognitive control in effort, further suggesting that cognitive control is essential to the explanation of all effort, be it mental or bodily. These features are effort choice (Kurzban 2016, Bermudez, 2023) and control (Massin, 2016; 2024). I end by illustrating that an everyday effort phenomenon prominently discussed by philosophers (Wu, 2016; Shepherd, 2017; Pacherie & Mylopoulos, 2021), namely the reduced effort required in skilled action, is best explained by cognitive control's role in mental and bodily effort.

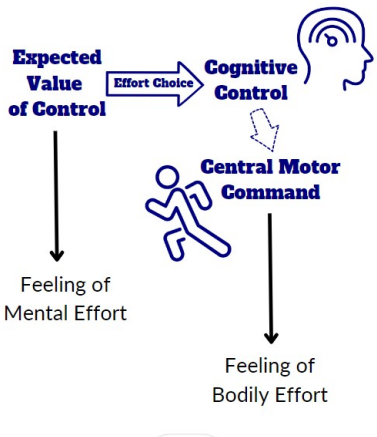

Figure 2: A full cognitive control account of effort

Effort reward and effort cost jointly determine the expected value of control. EVC leads to effort choice and feelings of mental effort. Cognitive control is deployed as a result of effort choice – a mental effort. If and only if cognitive control is deployed to issue central motor commands in an effort to generate voluntary controlled movement, the effort is considered a bodily effort and is accompanied by the feeling of bodily effort.

Argument 1:Subtraction Arguments

To clarify the relationship between mental and bodily effort, it is useful to consider subtraction cases. What is left of a bodily effort when subtracting all bodily aspects? What is left of mental effort when subtracting all mental aspects? A mental effort without mental aspects is impossible: one would simply be unconscious. What about bodily effort? Surprisingly, this question has been answered by empirical research. In a fascinating experiment, subjects (including the researchers) underwent total bodily anesthesia and were asked to make an effort to move their arm and inhale (Lansing & Banzett, 1993). Subjects reported their surprise at the result: they characterized their effort as mental (*"totally contrary to what I believed - there was no arm sense or diaphragm sense of effort"*; "It *was mental effort*").

In these experiments, cognitive control is present in the failed attempt at a bodily effort. However, the consequent issuing of motor commands is pharmacologically blocked, leading to a feeling of mental effort but no feeling of bodily effort. Subtracting bodily aspects from the bodily effort thus left subjects judging that they make a mental effort. This suggests bodily effort relies on a mental effort. It does not tell us whether this relationship of mental and bodily effort is that of a mere cause, or whether cognitive control/mental effort is necessary for bodily effort.

To illustrate why mental effort is more than just a cause, let's imagine your brain is being manipulated by transcranial magnetic stimulation (TMS). Central motor commands are caused, and you move as a result. It would be a mistake to consider this a bodily effort of yours, as there is nothing you are actively doing. TMS studies confirm this, indicating that the sense of agency characteristic for effort is caused upstream of motor commands rather than by the motor commands themselves: no feeling of effort is perceived (cf. Christensen & Gruenbaum 2018; Pageaux et al. 2023). Subjects reliably distinguish their effort from passive movement.

This shows that cognitive control is more than a mere cause of bodily effort: if it were, we would expect subjects to report making a bodily effort even when another cause is substituted for cognitive control.[6] We can expand this further by considering a variation of the experiment in which

[6] Substituting another cause, such as in the TMS example, does not lead to an effort. But could another mental act be substituted instead? This strikes me as unlikely for two reasons. If the act in question does not feature cognitive control, it must be purely automatic: this follows from the dual-process distinction employed here. Yet automatic processes are typically not believed to be acts, but mere behavior: think of the startle reflex, automatic word processing, or color perception. Furthermore, if a mental act that is not cognitive control could initiate and sustain bodily effort, we would expect this to be observable, but no

the subject themselves moves a heavy TMS device with their arm to cause central motor commands which lead to movement of the leg. In this case, the lifting of a heavy TMS device with one's hand would be an effort by the subject, yet the movement of the leg would not. Why? Both movements are caused by cognitive control. In the case of the heavy TMS device, cognitive control directly issues the central motor commands that bring about the movement: a bodily effort. In the case of the TMS-induced spasm of the leg, cognitive control does not issue central motor commands that bring about the movement – rather, it is merely causally involved in bringing the TMS into position, which then brings about central motor commands causing the leg's movement. This causal involvement of cognitive control is not sufficient to render the ensuing spasm a bodily effort by the agent. This provides evidence for my claim that cognitive control plays a more substantial role in the explanation of effort than that of a mere cause: cognitive control directly issuing (i.e., choosing and maintaining) the central motor commands that produce movement is necessary for a bodily effort to ensue.[7]

Here is a further conclusion we can draw from subtraction arguments: mental and bodily effort are not identical. As we saw, bodily effort must involve cognitive control/mental effort. But the reverse is not true. Mental effort does not require bodily effort. One can do math in one's head without making a bodily effort. Patients with locked-in syndrome or comparable severe disabilities are perfectly able to make substantial mental effort, as are patients who are paralyzed, such as famous physicist Stephen Hawking. Because bodily effort requires mental effort, but mental effort does not require bodily effort, they cannot be identical. My account captures this by explaining bodily effort as a deployment of cognitive control that issues central motor commands. Agents make a mental effort when deploying cognitive control; but one is not thereby also making a bodily effort unless cognitive control issues central motor commands.

To be clear, the subtraction question considered here is an extreme case. In normal circumstances, 'the body' is a central variable in effort. One may have an expanded or limited capacity to move depending on the strength of one's muscles, overall health, or sleep, all of which modulate the effort one makes. However, these factors do so by modulating the EVC of our effort: Lifting a heavy chair requires grit and great motivation of a child, but not of a powerlifter, for

such observation is reported in patients unable to engage in cognitive control. I thank an anonymous reviewer for raising this point to my attention.

[7] A reviewer rightly notes that one may reject the self-report of subjects that state TMS-induced movements are not effort. In this case, cognitive control would still be the cause of bodily effort in everyday effort: I return to this point in section 4.

example. The extreme subtraction cases considered here do not serve to deny the influence of such bodily factors in everyday effort..

In summary, we have used subtraction cases to argue that (1) cognitive control/mental effort is involved in bodily effort (2) cognitive control/mental effort issuing central motor commands is necessary for bodily effort and (3) cognitive control/mental effort is not identical to bodily effort.

Argument 2: The Effort Choice Argument

Effort does not happen to you – you choose and maintain your effort. Scientists (e.g. Kurzban, 2016; Shenhav et al, 2021) and philosophers (e.g. Bermudez, 2023; Holton & Holton, forthcoming) alike have argued that effort choice is the defining feature of effort.[8] To these authors, the core function of effort is the prioritization between different ways of engaging the world. Indeed, a key reason for the identification of mental effort and cognitive control in the cognitive science literature is that cognitive control explains effort choice for mental efforts (Kurzban 2013, 2016; Shenhav et. al 2017). This section argues for that the cognitive control account explains effort choice for both mental and bodily effort, thereby further establishing that cognitive control is a necessary and explanatorily powerful component of both mental and bodily effort.

Bodily effort is chosen by the EVC mechanism, just like mental effort. That is, EVC settles effort choice for all effort. This view is sometimes implicitly assumed but not explicitly defended in cognitive science. Let us review the solid neural and computational evidence for my claim that EVC is a shared mechanism for mental *and* bodily effort.

On intuitive grounds, we have good reason to expect a shared mechanism. As evolutionary psychologist Kurzban (2016) suggests, in both the ancestral and the current environment, limitations to our ability to multitask cut across domains. You cannot map a new path to your camp while fighting a mammoth. To prioritize well, agents must use a mechanism that is able to compare mental and bodily options, and EVC is the natural candidate.

[8] Here, I do not independently argue for the claim that effort choice is the defining feature of effort. Usually, the claim is motivated by the function of the feeling of effort being the evaluation of different action options, and the ensuing effort functioning as a prioritization between action options. The reader skeptical of such a functional explanation will hopefully still find the novel arguments for a unified effort choice mechanism informative, regardless of whether it establishes a constitutive role for cognitive control in the explanation of effort.

Conditions that affect the motivation for effort cut across domains, indicating a shared mechanism. The willingness to make an effort decreases with age for both mental and bodily effort (Maillot et al., 2018). Apathy, as seen in patients suffering from dementia, depression, or schizophrenia, affects both mental and bodily effort (Vinckier et al., 2022; Culbreth et al., 2023). The EVC model is the best fit for predicting mental and bodily procrastination behavior, as recent work by Lebouc and Pessiglione (2022) shows.

There is strong evidence suggesting bodily and mental effort share a 'currency,' as would be typical for a shared mechanism. Some of this evidence is neurological. The ventral striatum is thought to encode the subjective expected value of reward and punishment in a domain-general fashion. Lesions in the striatum confirm this: Patients stop being sensitive to incentives for both mental and bodily effort when striatum function is compromised while retaining the ability to perform effort upon instruction (Habib & Poncet, 1998). Behavioral and computational evidence further suggests the cost of mental and bodily efforts is computationally commensurable and integrated (Chong et al., 2017; Bustamante et al., 2023; Clairis & Pessiglione 2024), a finding that only a shared EVC mechanism can explain.

Effort evaluation for both cognitive and bodily effort is controlled by shared neural populations, particularly in the dorsal medial prefrontal cortex (dmPFC) and dorsal anterior cingulate cortex (dACC), both associated with EVC (Lopez-Gamundi et al., 2021; Clairis & Lopez-Persem 2023). It would be a surprise if EVC shared these neural structures so closely with a second, independent evaluation mechanism.

Lesions to these areas, observed in dementia or after stroke, reduce the propensity to choose to make mental and bodily effort, sometimes even leading to akinetic mutism (Darby et al., 2018; Le Bouc et al., 2022). The opposite is true when the areas in question are stimulated using transcranial magnetic stimulation or intracranial electroencephalography: Then, subjects increasingly choose to perform mental and bodily effort (Soutschek et al., 2022, Clairis &Pessiglione 2024). Both findings indicate that a shared mechanism underlies effort choice.

In short: There are strong empirical and theoretical reasons to believe EVC, which is firmly tied to cognitive control deployment, is the shared mechanism that governs effort choice for *both* mental and bodily effort. It is via cognitive control/mental effort that EVC determines the central motor commands/bodily effort to issue. Effort choice has often been identified as the defining feature of

effort. That would make put cognitive control at the heart of any explanation of effort: the cognitive control account of effort captures this.

Argument 3: Control and Failure

Efforts are under agential control. As we just saw, effort is the manifestation of choices to prioritize specific tasks over others, as many evolutionary biologists, neuroscientists, psychologists, and philosophers agree (Kurzban, 2016; Shenhav et al., 2021; Bermudez, 2024; Holton & Holton, forthcoming). Among these choices is the degree to which we make an effort; this direct control we have over both the kind of effort we make and the intensity of the effort we make is often identified as a central feature of what it is to make an effort (e.g. Massin, 2016; Massin & Bermudez, 2023; Shenhav et al., 2021; Lieder et al, 2017). Yet even in bodily effort, this control is typically a matter of cognitive control, rather than bodily factors. Whereas we don't have direct control over bodily aspects of effort, such as our muscle's composition or our maximal flexibility, we have direct control over how to use our bodies: control that is explained by cognitive control.

To see this more clearly, consider cases of failure. Most failures at bodily effort are mental. It's pretty rare to fail at a bodily effort because of one's body. I usually fail at running because I decide to push onward no longer, not because I collapse on the ground.[9] Similarly, I abort sudokus not because I fall unconscious but because I switch to my social media feed. Such task-switching and task maintenance are firmly within the domain of cognitive control. In both cases, tasks are deprioritized when EVC (maybe mistakenly) suggests higher value of more leisurely tasks and redirects where we deploy our cognitive control.

Now consider a pole vaulter who fails at a jump: she, too, is in control over the mental, but not the bodily factors of her jump.[10] For example, it seems that she can fail by becoming distracted. Maybe a loss of focus on the step pattern leading up to the jump (issuing the wrong central motor command?) or an insufficient mental effort at tensing her body or a lack of determination as she

[9] The exception, of course, is training to failure: Exercising so hard that one's muscles simply stop working. While rare, I take it that these are not cases of agents ending their effort, but simply cases in which one's bodily limitations "knock out" the effector organs that are the targets of effort. Notice that the mental effort to 'push through' continues briefly after the muscles falter. Similarly, agents do not end their mental effort when an anesthetic knocks them out: their effort is interrupted by non-agential factors, rather than aborted by the agent.

[10] I thank an anonymous reviewer for the suggestion.

jumps may thwart her jump. These would be failures of deploying cognitive control in the right way or intensity.

Contrast this with bodily failures: maybe her muscles are not strong enough for the ambitious jump height. These failures are not under her direct agential control: overcoming them would require more training. I do not want to defend the idea that all failures are attributable to mental factors.

Where this connects to my broader claim is that effort can mitigate failures only of the mental kind, because those are the aspects of the effort that are under direct control. What is within our direct control in preventing failure at pole vaulting is how we use cognitive control to move our bodies, a well-established mechanism tied to agential control (cf. footnote 3). Direct control over our efforts, both regarding the kind and intensity of a chosen effort, has often been identified as a central feature of what it is to make an effort (e.g. Massin, 2016; Massin & Bermudez, 2023; Shenhav et al., 2021; Lieder et al, 2017), as it instantiates the agential features characteristic of effort. But this direct control is a matter of the cognitive control mechanism – even in straightforwardly bodily effort, such as a pole vault. The cognitive control view puts forth a unique and fitting explanation for the mental character of control over bodily effort by considering the interplay of EVC, cognitive control and central motor command.

Argument 4: Learning and Effort

Here is an obvious observation often discussed in the philosophical literature on skill: As I learn to improve my skills on a task, future iterations of the task require less effort. Keeping this in mind, here is a worrying observation: No current theory of effort explains why this is the case. Contemporary theories of mental and motor learning and skill suggest that learning takes place when the cognitive control required for a task is reduced (rather than force, feeling, or glucose, the respective building blocks of rival theories of effort). To make sense of the everyday observation that skill reduces the effort required by a task, the role of cognitive control in effort must be addressed, as the cognitive control account of effort does.

Learning of skilled action consists of changes to the interplay of automatic and cognitive control processes, as a strong and convergent body of evidence from decades of research suggests (Fitts, 1964; Shiffrin & Schneider, 1977; Wiestler & Diedrichsen, 2013, Hodges & Lohse 2020). We learn skilled actions by reducing the number of cognitive control processes required to perform a task. Remember that the cognitive control account suggests that efforts *are* the deployment of

cognitive control. Naturally, then, reducing the number of cognitive control processes as we learn reduces the effort of subsequent tasks. To drive home this point, the rest of this section reviews some key results in the study of learning.

In the psychological literature, learning is often divided into stages based on the level of cognitive control involved (Tenison & Anderson, 2016). At the beginning of the learning process, executive rehearsal (i.e., repeatedly solving the task using cognitive control) is used because no automatic processes are capable of solving the task.

To illustrate, consider a child counting upwards using their fingers, a process requiring cognitive control. After practicing, the child enters a second stage, when automatic processing can handle parts of the task. Prompted to add 5+3, the child is not yet able to automatically recall the result but recalls that a hand has five fingers. Cognitive control is now only required to add the fingers of the second hand, as counting starts at 5. At this stage, both automatic (5!) and cognitive control processes (6, 7, 8!) contribute to success (Fitts, 1964; Shiffrin & Schneider, 1977; Hardwick et al., 2019). In the last stage, one relies exclusively on automatic processing. As a competent adult, adding 5+3 requires no explicit calculation. You simply remember the result, and no feeling of mental effort arises (Wiestler & Diedrichsen, 2013; Hodges & Lohse, 2020). The cognitive control required to complete the calculation has been minimized.

The stage model of learning can be applied to a broad array of tasks across different domains, such as cognitive, perceptual, and motor tasks. A comprehensive model of effort is necessary to explain why this stage model of learning is applicable to both mental and bodily tasks. The cognitive control of effort not only identifies the correct mechanism that is adjusted during the learning process, but also elucidates how this mechanism is relevant to both mental and bodily effort.

Chunking is another crucial concept in the study of learning that makes sense only from a cognitive control perspective (Gobet et al., 2001). Imagine being asked to memorize the number 1801412999. Memorizing number “chunks” such as 180 - 1412 - 999 will require much less focus than memorizing each digit individually. Instead of remembering ten individual numbers, you only need to remember three chunked numbers. Chunking reduces the steps required to perform the task and, thereby, the cognitive control required. Importantly, chunking is not exclusive to mnemonic feats. Humans chunk the motor sequences involved in bodily effort, too, when they

practice. This improves performance by reducing the cognitive control required to execute the movements.

Interestingly, many skills that enable impressive bodily effort can be improved upon by mental rehearsal (Ryan & Simmons, 1981), a purely mental form of learning in which subjects imagine executing the movements in question. That mental rehearsal decreases the effort a bodily task requires is unsurprising on a cognitive control view, which emphasizes the mental aspects of effort. It remains entirely unexplained on any other view.

This section reviewed key results in the empirical study of learning and related them to the role of effort in skill. The upshot is that learning happens when the cognitive control required by a task is reduced. Importantly, this result holds for both bodily and mental tasks, where reducing the required cognitive control over time leads to reduced required effort. As the cognitive control account argues, effort is the deployment of cognitive control. This matches the key cognitive mechanism in the study of learning, explains our initial observation that learning reduces effort required across domains, and explains why learning mechanisms typically generalize across mental and bodily tasks.

Summing Up

The previous four sections reviewed arguments for the cognitive control view. First, it was argued that cognitive control/mental effort is (1) involved in bodily effort (2) necessary for bodily effort and (3) not identical to bodily effort. Then, three central features of effort identified in the philosophical literature were discussed: choice, control and skill. I argued that all three features are best captured in terms of cognitive control, regardless of whether the effort in question is mental or bodily. This further illustrates why cognitive control plays a necessary role in the explanation of bodily effort: essential features of effort are, in fact, features of cognitive control.

A skeptical reader may disagree with some of the empirical evidence presented here, or consider other features of effort more important to the concept than choice, control and skill. We will discuss one such case soon when we reconsider force views. Such a skeptical reader will likely opt for a causal reading, on which cognitive control is causally required for, but not necessary for, effort. That is fine: productive disagreement on the exact role of cognitive control in effort is welcome. The analysis provided on the relationship between cognitive control and central motor command,

as well as on the unified mechanism underlying effort choice and control, is novel and fruitful regardless of whether one favors a constitutive or causal reading.

4. The Cognitive Control View and Alternatives

It is time to circle back and take stock of the current debate on effort. How do different theories fare in comparison to the cognitive control view?

Let's start by discussing the relationship between effort and its feelings. On the cognitive control view, feelings of effort are fully explained. The feeling of mental effort arises from the EVC of current cognitive control deployments. Additionally, the feeling of bodily effort arises as an upshot of central motor commands, which are themselves issued by cognitive control deployments. This picture is philosophically satisfying, as it provides a straightforward representationalist story of effort and the accompanying feelings: To make a mental effort is to deploy cognitive control, and to make a bodily effort is to deploy cognitive control that issues central motor commands. The feeling of mental effort and the feeling of bodily effort thus represent the effort by being phenomenological upshots thereof.

Feeling-first views struggle with the relation between effort and the feelings of effort. On feeling-first views, to make an effort is to act with a feeling of effort. However, making an effort and experiencing the feeling of effort are clearly distinct. Lesion patients who experience no effort or athletes entering flow states of effortless absorption can make an effort even without experiencing a feeling of effort (Csikszentmihalyi, 2002; Naccache et. al., 2006). Such real-world anomalies are possible on the cognitive control view but ruled out by feeling-first views because the latter consider feelings essential to any effort.

Current effort theories poorly explain the involvement of mental effort in bodily effort, as considered in the effort choice and the subtraction arguments. Resistance views lack the concept of mental force and are thus generally remain silent on mental effort. Resource- and feeling-first views see effort as arising from two largely independent resources/feelings, with none of them enjoying primacy.

Of the views considered, resistance views are plausibly the most developed, so I will spend some time discussing synergies. Resistance views face the crucial challenge of explaining what a mental force is. Here, our discussion of cognitive control can help.

Massin alludes to mental forces resisting our desires or temptations, without developing a concept of mental force (Massin 2024). Note that such resistance is well within the domain of cognitive control. Furthermore, cognitive control is often studied in adversarial paradigms where automatic and cognitively controlled processes 'compete' to determine which behavior is produced (Hardwick et al., 2019). In computational paradigms of cognitive control, such as the popular sequential sampling models, the strength of both processes is expressed as a vector (Sripada, 2025). For resistance views, such models offer an opportunity to explain what a mental force is: the cognitive control exerted to overcome a resistive force, namely automatic behavioral impulses. This view would be empirically attractive, philosophically insightful and crucially advances the research program of resistance views.

Are my view and the resistance view equivalent, then? No. Resistance views might benefit from using cognitive control to explain mental forces, yet important differences remain. I explain bodily effort in terms of central motor command, the neural signature of voluntary movement that produces the feeling of bodily effort, rather than in terms of physical force.[11] This leads to an attractive representationalist picture of the feeling of effort which I sketch in figure 2. More importantly, whereas I take cognitive control to be necessary for bodily effort, Massin would plausibly prefer a mere causal reading. My account uniquely explains, for example, the phenomenon of learning in skill, and offers attractive explanations of the normative profile of effort, as we will see, because it takes cognitive control to be more than a causal antecedent of mental and bodily effort.

5. The Benefits of Unification

Why unify? The cognitive control view of effort provides an empirically plausible, philosophically rich picture of effort. Its central benefit to cognitive scientists and philosophers lies in its unification of mental and bodily effort. But why unify? As this section illustrates, the mental-first view captures many threads in the descriptive and normative domain that are, implicitly or explicitly, dependent upon a unification of effort by the mental.

[11] See Massin (2025) for an interesting alternative explanation for the role of the feeling of effort.

In order to understand research results on effort, we need a unified theory of effort. As discussed in section 3, aging, dementia, akinetic mutism, and striatum lesions affect mental and bodily effort alike. So do motivational changes (e.g., increasing or decreasing expected reward).To make sense of this growing body of evidence finding parallels between mental and bodily effort, we need a unified theory of effort—one that the cognitive control account of effort uniquely provides.

Responsibility, Praise and Blame

A unified theory of effort could also make progress in cognate ethical debates. For example, one may wonder if efforts are an appropriate subject for praise and blame. In everyday life, we often praise or blame people for the kinds of effort they make, we appreciate the products of great effort and recognize the difficulty of great effort. This normative profile has led to many ethicists taking an interest in effort, with some vindicating and others rejecting the intuition that effort modulates praise- and blameworthiness or other moral concepts (e.g, Bradford, 2013, 2015, 2016, 2017; Nelkin, 2016; Guerrero, 2017; von Kriegstein, 2017, 2019; van Ackeren, 2018; Chappell, 2019; Hirji, 2019; McElwee, 2022; Dunkle, 2023; Kieval 2024).

Is it appropriate to modulate responsibility based on the agent's effort? Imagine I urgently require medical attention; my partner makes a great effort to provide the medications quickly. This intuitively warrants praise, regardless of whether the effort involved was mental or bodily. Contrast this with him only making a half-hearted effort. This intuitively warrants blame. If we want to embrace a position where effort modulates praise and blame, it is important to note that we praise agents for their choices, not the force, feelings, or glucose levels involved. It thus seems easier for the cognitive control account to vindicate these judgments.

On the cognitive control view, effort reflects an agent's decisions. EVC provides a value-based choice between options. Effort choice reflects the cares and values of the agent who makes the effort because EVC is sensitive to them. A person who does not devote full attention to a resuscitation attempt, for example, neglects the value of life. This can be seen from the low expected value attributed to the resuscitation effort, leading to its deprioritization. It strikes me as plausible that we find this blameworthy on standard accounts, regardless of whether we ground blame in motivation, protest or will-based concepts. A person who gives it their all, braving unlikely

odds in an attempt to save someone, seems to value life highly – an attitude we may praise, even if the effort ends up unsuccessful.[12]

Much more can and will be said about the value of effort (Bradford, 2015; Nelkin, 2016; von Kriegstein, 2016; Guerrero, 2017; Chappell, 2019), and I do not seek to provide a complete analysis of this topic here. For now, this brief illustration shows how the cognitive control view can provide plausible answers to questions about the value of effort.

Difficulty

Now let us move on to other concepts that illustrate the benefit of unification. Consider difficulty, which is clearly a characteristic of both mental and physical tasks. Some theories of difficulty explain it in terms of effort (Bradford, 2015; Massin, 2024). Some take a hybrid approach, in which effort is one of multiple factors that makes tasks difficult (Nelkin, 2016; Kriegstein, 2019). Others deny the role of effort in difficulty (Dunkle, 2019, forthcoming).

Without a unified theory of effort, it is hard to explain bodily or mental difficulty in terms of effort. Gwen Bradford, a leading theorist on difficulty, laments the lack of a unificatory theory of effort and provisionally embraces primitivism about effort, suggesting that effort is not subject to further explanation (2015). Massin (2024) invokes a multi-tiered account in which the difficulty of physical effort is determined by its intensity and the physical strength of the agent. Then, as the aversive feeling of effort sets in, a second-order effort is required: the agent exerts a mental force against the temptation to give up. But as we discussed earlier, what a mental force is, on this account, remains unspecified. The cognitive control theory of effort eliminates the necessity for resorting to primitivism or multi-tier analyses. It offers a clear explanation of what makes a task difficult: the level of cognitive control required determines the difficulty of a task. Regardless of whether one takes effort to be the only source of difficulty, one of multiple sources of difficulty, or to be irrelevant to difficulty, this account constitutes progress. By clarifying a central concept used in many theories of difficulty, the cognitive control perspective presents a tractable and empirically sound theory of difficulty that philosophers can engage with.

[12] I do not wish to suggest that more effort is always more praiseworthy. For example, imagine my spouse had to sacrifice their favorite guitar to save my life. I would find it praiseworthy if giving up the guitar were effortless, rather than if great effort were involved in resisting the urge to retain the guitar. The latter would reflect a neglect for the value of my life, analogous to the case I discuss above. I thank an anonymous reviewer for this point.

Achievement

Now consider achievement, which some theorists believe to be valuable because of the effort involved (among, possibly, other things). Once more, it's evident that a unified theory would be helpful: Both Magnus Carlsen and Usain Bolt are admired for their effortful achievements, after all. However, when considering why achievements are admirable, intuitions often turn mental. It is the grit and resolve needed for decades of high-performance training that are reflected in competently performing great feats of strength. When corners are cut, such as by chemical enhancement, regard for the performance dramatically diminishes. Lance Armstrong's performance may have surpassed that of a clean athlete in terms of pure physical force, but the fact that he used doping to enhance his strength, recovery, and stamina diminishes the value of his achievements. Value is diminished precisely because his doping makes it hard to establish which of his feats arose from his grit and resolve and which were merely a product of his willingness to take chemicals that boost his performance. Understanding these aspects of achievement in terms of effort requires not just unification, but mental primacy. As the mental is so central to the value of bodily achievements, explaining achievement in terms of effort requires a theory that puts the mental at the heart and center of effort, as the cognitive control account does.

Human and Non-Human Effort

Before wrapping up, two more speculative threads of unification should be mentioned.

The first concerns non-human effort. It is readily apparent that humans are not the only creatures capable of effort. Think of a baboon spending hours fending off a rival's intrusion or a cat climbing a tall pantry to get to a box of treats. Nevertheless, the possibility of non-human effort is mainly ignored or even denied by philosophers.[13] The cognitive control account gives us a tractable criterion to judge which entities have a capacity for effort: Those with the capacity for cognitive control or functional equivalents.

Which animals have this capacity for cognitive control? Neural similarity between cortical structures in humans and other mammals makes them a likely candidate. Indeed, many mammal species perform well on species-appropriate adaptations of classical cognitive control paradigms (Eagle et al., 2008). Other animals, such as birds or crocodiles, have evolved analogous, but not

[13] A welcome exception is Kieval, 2024.

identical, neural structures that seem to enable higher-order control and inhibition akin to cognitive control. Behavioral evidence here is promising but less decisive than in the mammalian case (Grendeus & Reber, 2020; Bobrowicz & Grief, 2023). It is an open question which other entities may be thought of as having a capacity for cognitive control. How should we think about, e.g., amphibians? Fish? Artificial agents, such as AI? Group agents, such as companies or states? The cognitive control account does not answer these questions. It is an account targeted at human effort. But from it, we can uniquely derive structural and behavioral criteria to judge which creatures can perform efforts, namely, those creatures possessing appropriate higher-order control structures that inhibit automatic responses and govern the choice of voluntary controlled behavior. Research into the hierarchies of control in animals and machines is well underway in philosophy and psychology (e.g., Merel, Botvinick & Wayne, 2019; Kieval, 2024). This research will help settle the question of how widespread the capacity to make efforts is.

A last possibility of using the mental effort first approach concerns the nature of trying, willing, and action. The literature on effort typically describes it as a notion akin to trying or attempting (e.g., Kurzban, 2016; Massin, 2017; Bermúdez & Massin, 2023). Making an effort is engaging with a task in a voluntary and controlled fashion. This ties the notion of effort closely to action. Some philosophers think all actions are events caused by a trying (Armstrong, 1973), others take actions to be tryings (Hornsby, 1980), trying to be the essence of action (Smith, 1988), or all effort to be actions (Massin, 2017; Massin, 2024; Bermúdez & Massin, 2023; Bermúdez, 2024). If these philosophers are right, thinking of effort as a basic building block of action may be appropriate.

On the cognitive control view, these basic building blocks look especially attractive: Effort choice and deployment are a mental willing to prioritize a certain task engagement over others. This would suggest that the most basic actions or proto-actions are deployments of cognitive control. All complex action, such as movement or sustained thought, requires the more basic deployment of cognitive control. Without developing these thoughts in full detail, the importance of mental effort and cognitive control in elucidating the nature of trying, willing and action has recently received great attention by philosophers (e.g. Sripada, 2020, 2025; Wu, 2023; Buehler, 2023). It is my hope that the cognitive control account developed here serves to further fuel this crucial research program in the philosophy of action.

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