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**Understanding Self-Control:
The Role of Metacognitive Beliefs and Strategy Use**

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Abstract

Self-control allows people to align their behaviour with intention in the face of a motivational conflict. Successful self-control predicts positive long-term outcomes in terms of career, health, and social relationships. Recent research highlights the role of metacognition in self-control performance. This dissertation examines people's metacognitive beliefs about self-control, how these beliefs vary depending on individual characteristics, and how they relate to strategy use in everyday self-control situations and at the level of executive function (EF). In the first two studies, we find evidence that beliefs about the short-term limitedness versus long-term malleability of self-control are relatively independent of each other. Moreover, limitedness beliefs vary depending on the self-control domain. Our results thus support a multidimensional and domain-specific approach for measuring self-control beliefs. Next, we demonstrate that people's beliefs about self-control depend on whose self-control they are thinking about. If people are told that a person has ADHD, they are more likely to view this person's self-control as a limited resource and a fixed trait. Moreover, people with strong ADHD traits appear to view their own self-control as more limited and fixed. By contrast, we find no consistent association between people's self-control beliefs and their knowledge and use of different self-control strategies. In the last two studies, we further investigate metacognition and strategy use, focusing on specific EF subprocesses. Our findings suggest that the benefits of verbal strategies are not limited to information maintenance: verbal representations may also support the efficient updating of task-relevant information. However, contrary to our hypothesis, self-control beliefs were not associated with performance in an EF task. These results are discussed in relation to existing literature to propose an integrative framework of how metacognitive beliefs, EF, and strategy use interact to enable self-control.

Lay Summary

We often need to push ourselves to follow our commitments and goals despite competing impulses or temptations. For example, we may have to focus on a work assignment despite getting notifications from our favourite mobile app or we may need to suppress the urge to make a blunt comment during a family dinner to maintain a good rapport. In other words, we need self-control. People have different beliefs about the nature of self-control, and these beliefs may affect people's behaviour in situations that require self-control. The aim of this dissertation was to increase our knowledge of how people think self-control works, what kind of things affect people's beliefs about self-control, and how these beliefs relate to people's behaviour. An additional goal was to examine the strategies people use to deal with everyday self-control challenges and when completing an experimental mental task. The results suggest that people's beliefs about self-control are nuanced: a person can think that self-control is a limited resource in the short term but still believe it can be modified in the long term – and vice versa. Moreover, people can also hold different beliefs about different types of self-control. For example, the ability to keep working on mentally effortful tasks may seem more limited than the ability to resist temptations. Moreover, people express different views about the nature of self-control depending on whose self-control they are thinking about. If someone has ADHD, people think that this person's self-control is more like a limited resource and a fixed trait. In addition, people with ADHD also appear to view their own self-control as more fixed and limited than people without ADHD. By contrast, there was no clear evidence that self-control beliefs would be linked to people's knowledge and use of different self-control strategies. Finally, studies focusing on mental tasks suggested that language can support information processing in multiple ways. However, performance in the mental task did not depend on self-control beliefs. These results can help us to better understand how beliefs, mental abilities, and strategies work together enable self-control. Eventually, this research can guide us to support people in reaching their goals and living up to their commitments.

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Chapter 1 Introduction

Our daily lives often involve situations in which we are torn between competing, contradictory motives. We may get an impulse to open our favourite mobile app although we ought to focus on a work assignment or we may feel an urge to blurt out a blunt comment while our friend is talking although we do not want to hurt their feelings. These kinds of motivational conflicts call for *self-control* – that is, they require us to align our behaviour with our motivational commitment when we are challenged by conflicting impulses (Koi, 2023). People face self-control challenges in various domains, including education, work, social life, and health behaviour. Indeed, there is an ample of research reporting that success in self-control predicts positive long-term outcomes in academic achievement, employment, health, and social relationships (e.g., Allemand et al., 2019; Daly et al., 2015; Moffit et al., 2011).

Traditionally, self-control has been equated with intrapsychic processes such as effortful inhibition of tempting impulses (Bermúdez et al., 2023; Hofmann, 2024). However, more recent work in psychology and philosophy argues for a more multifaceted view of self-control (Duckworth et al., 2016; Hofmann, 2024; Milyavskaya et al., 2019; but see Sripada, 2021). Research suggests that instead of effortful inhibition, self-control success is based on adaptive use of a broad strategy repertoire, encompassing situational strategies by which people actively shape their environment to support their goal pursuit. This “toolbox” view of self-control has highlighted the role of *metacognition* in skilful self-control (Hennecke & Bürgler, 2023; see also Werner & Ford, 2023). Here, metacognition refers to knowledge and beliefs of how self-control works, what kind of self-control strategies exists, how to use them, and in which contexts they are most effective.

An important aspect of such metacognition are people’s beliefs or implicit theories about the limits of self-control. So far, research on self-control beliefs has mainly focused

on whether people view self-control as a limited or nonlimited resource in the short term (Francis & Job, 2018; Li et al., 2024). Studies have shown that a less limited view of self-control is associated with better self-control performance in both laboratory tasks and real-life (Francis & Job, 2018; but see also Toyama et al., 2022). However, the existing research on self-control beliefs has some important limitations. Firstly, studies have so far largely ignored other possible dimensions of self-control beliefs (but see Li et al., 2025). In particular, there is very little research on whether people see self-control as fixed versus malleable in the long term – although this has been the main question in research on beliefs about other psychological attributes, such as intelligence (see Dweck & Yeager, 2019). Including this dimension in the assessment of self-control beliefs would provide a more comprehensive picture of people's metacognitive beliefs and allow a better understanding of how these beliefs are associated with real-life self-control (see Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010).

In addition, research has not distinguished between the views people hold about their own versus other people's self-control. Existing studies appear to mainly assess people's views of their own self-control. However, it would also be important to understand how we reason about the self-control abilities of other people. Our beliefs about other people's self-control may affect how we interpret their behaviour in everyday situations (see Eme, 2016; Kennett, 2013; Koi, 2021). Moreover, these beliefs could depend on the characteristics of the other person. Attention Deficit/Hyperactivity Disorder (ADHD) is a well-known neuropsychiatric diagnosis characterised by attention difficulties, hyperactivity, and impulsivity. As ADHD traits may cause additional challenges for self-control, ADHD has even been characterised as the paradigmatic disorder of self-control (Eme, 2016; but see Koi, 2021). Thus, people's beliefs about other person's self-control might change if they know this person has an ADHD diagnosis.

Furthermore, relatively little is known about whether people's self-control beliefs are associated with their knowledge and use of different self-control strategies. Believing that self-control is a nonlimited resource and malleable in the long-term could motivate the development and use of a broad strategy repertoire (see Haimovitz et al., 2020). On the other hand, understanding self-control as an umbrella concept encompassing both intrapsychic and situational strategies could in itself foster more nonlimited and malleable beliefs about self-control.

The present dissertation aims to examine these questions. In this introduction chapter, I will first define self-control based on psychological and philosophical research literature. I will argue that self-control should be understood as a multifaceted, context-dependent phenomenon, which relies on both intrapsychic and situational strategies. Second, I will review the existing research on the role of metacognition in successful self-control performance, with a focus on lay beliefs about self-control. Third, I will discuss the implications of this body of research on how to measure self-control and further examine the relationship between self-control and executive function. Finally, I will outline the empirical studies conducted for this dissertation.

1.1 Self-Control

Broadly defined, self-control is what allows us to align our behaviour with a motivational commitment, such as an intention or better judgment, in the face of conflicting impulses of motives (Koi, 2023; see also Fujita et al., 2025; Goschke & Job, 2023). The term is sometimes used interchangeably with *self-regulation*. However, several researchers have argued for a more systematic terminology in which self-regulation describes a broader group of processes that involve monitoring and modulating one's thoughts, emotions and behaviour in a goal-directed manner, whereas self-control refers to specific instances of self-regulation which involve a motivational conflict (Fujita et al., 2025; Milyavskaya et al.,

2019). In other words, self-control is always an instance of self-regulation, but self-regulation does not necessarily involve self-control. For example, a tennis player needs to regulate their thoughts, emotions, and movements during a match, but – assuming that the player wants to win and does not have a countervailing desire to fail – there is no motivational conflict. Hence, this would be an example of self-regulation, but not of self-control.

Different research traditions in psychology and philosophy have offered varying definitions of motivational conflicts relevant to self-control (see Fujita et al., 2025; Koi, 2023). The temporal discounting approach highlights the trade-off between the magnitude and timing of rewards (e.g. Ainslie, 1975; see Fujita et al., 2025). Here, motivational conflicts emerge when our desire to gain smaller short-term rewards (e.g., binge eating sugary snacks) collide with our commitment to attain larger long-term rewards (e.g., the health benefits of a balanced diet). However, arguably, there are also self-control conflicts that do not involve these kinds of intertemporal choices (Fujita et al., 2025). For example, when a group of individuals needs to ration the use of a common resource (e.g., limited supply of electricity in an electric grid), failures in self-control may not yield even short-term rewards: if multiple individuals lapse, the resource may run out immediately.

By contrast, the dual-process or dual-systems approaches suggest that self-control dilemmas arise from conflicts between two information processing systems, such as "hot" emotional versus "cool" cognitive processing or automatic versus controlled processing (e.g. Hofmann et al., 2009; Metcalfe & Mischel, 1999; see Fujita et al., 2025). From this perspective, self-control is needed when emotion-driven or impulsive urges (e.g., replying immediately and harshly to a negative remark made by a colleague) conflict with more dispassionate or intentional choices (e.g., responding more constructively to negative feedback). However, one limitation of the dual-process theories is that it is unclear why

one processing mode should be considered superior to another. Thus, it is difficult to define self-control success. Indeed, research suggests that emotions and automatic processing can sometimes play adaptive roles in long-term goal pursuit (see Fujita et al., 2025; Goschke & Job, 2023).

Recently, it has been proposed that the motivational conflicts relevant to self-control should be understood as problems of regulatory scope (Fujita et al., 2025). Regulatory scope refers to the range of perspectives one considers in any decision or behaviour. According to this view, self-control challenges do not arise exclusively from intertemporal choices nor reflect a dichotomous competition between two processing systems. Instead, the overarching conflict is between contractive versus expansive regulatory scope. A more contractive scope focuses on the concerns closest to oneself in one's immediate environment, whereas a more expansive scope accounts for a greater range of relevant concerns - including concerns that span a greater psychological distance in terms of time, space, people, and possibilities. This definition of self-control encompasses the conflicts between smaller short-term versus larger long-term rewards, but it also captures other situations that can be understood as self-control dilemmas, such as conflicts between the interests of oneself versus the broader collective.

What exactly are we doing when we exert self-control? Successful self-control proceeds from identifying the motivational conflict to resolving it (Myrseth & Fishbach, 2009; Werner & Ford, 2023). Traditional conceptions of self-control have often equated it with intrapsychic processes such as the effortful inhibition of unwanted behaviour (see Bermúdez et al., 2023; Hofmann, 2024). However, such intrapsychic strategies are not the only way to resolve motivational conflicts. The process model of self-control describes a broad range of self-control strategies, organised based on the timeline of the developing tempting impulse (Duckworth et al., 2016; see also Werner & Ford, 2023). The key idea is

that impulses develop over time and self-control can be resolved at any stage of the process - even before we actually experience the motivational conflict. At the earliest stages of the impulse generation, we can utilise *situational strategies*. That is, we can select and modify our circumstances such that our environment supports our commitment and alleviate any motivational conflicts. For example, instead of relying on sheer willpower to ignore the distracting notifications on your phone, you might simply disable notifications or leave your phone in a different room. Sometimes the best way to resist impulses might be to avoid them from arising in the first place.

Accordingly, empirical research suggests that self-reported self-control success in everyday life is not meaningfully associated with task-based measures of inhibition and other top-down cognitive processes (Eisenberg et al., 2019; Saunders et al., 2018; see also Duckworth & Kern, 2011). Moreover, there is some evidence that self-report measures may be better predictors of real-life outcomes than task-based measures (Eisenberg et al., 2019). Interestingly, people who report strong trait self-control also report experiencing fewer problematic desires in their everyday lives than people with poorer trait self-control (see Hofmann, 2024). In addition, they are better at avoiding distractions or tempting situations and at selecting themselves into (social) environments that support their goals. Hence, in real life, resolving motivational conflicts is not simply a question of effortful inhibition. Rather, people who excel in self-control appear to actively shape their environments by using a repertoire of different strategies. At the same time, people's self-control success is also shaped by environmental factors outside their direct control, from the specific characteristics of their immediate physical and social surroundings to broader sociocultural structures (Hofmann, 2024; Michaelson & Munakata, 2020).

1.2 Self-Control and Metacognition

Understanding self-control as encompassing a host of different strategies and being shaped by various contextual factors highlights the importance of *metacognition* in self-control success (Bürgler, & Hennecke, 2024; Hennecke & Bürgler, 2023; Werner & Ford, 2023). In this context, metacognition refers broadly to cognition about the cognitive, motivational, and affective phenomena relevant to self-control (Hennecke & Bürgler, 2023). This encompasses (1) people's individual metacognitive characteristics, including their metacognitive knowledge about self-control and their self-awareness, and (2) metacognitive regulatory processes that may be needed before, during, and after a self-control conflict, allowing the efficient implementation of self-control strategies and adaptive responses to changing situations.

If we view self-control as a toolkit, then successful self-control depends partly on people's understanding about the features of that toolkit as well as their skilful selection and use of its tools. Some tools might be helpful in various situations, but the exact usefulness of any single self-control strategy depends on the specific goal as well as the characteristics of the individual and their environment (Bürgler, & Hennecke, 2024; Hennecke & Bürgler, 2020; Hofmann, 2024). For example, while certain situational strategies may be effective in many contexts, we cannot always freely select or modify our surroundings. In addition, some individual cognitive differences could affect people's access to intrapsychic self-control strategies. Furthermore, both our environments and our mental capacities vary over time for numerous reasons (e.g., social dynamics, fatigue, stress) and the adaptiveness of a given strategy might therefore change during the self-control challenge.

Dealing with all this complexity requires metacognitive knowledge and skills (Bürgler, & Hennecke, 2024; Hennecke & Bürgler, 2023). Choosing an adaptive self-

control strategy requires general, declarative knowledge and beliefs about the nature of self-control and different self-control strategies. It also relies partly on contextualised, conditional knowledge about the situational and personal characteristics that affect self-control and on beliefs about when different strategies are adaptive. Finally, to successfully exert self-control, one needs procedural knowledge about how to implement different strategies as well as metacognitive regulatory processes to actively monitor and adjust one's actions.

One important aspect of metacognitive knowledge are people's beliefs about the nature of self-control (Francis & Job, 2018, Hennecke & Bürgler, 2023; Li et al., 2024). Research on this front has mainly focused on whether self-control is viewed as a limited or nonlimited resource – that is, do people believe that exerting self-control is followed by a temporary shortage of self-control resources (see Francis & Job, 2018). A less limited view of self-control is associated with better self-control performance in both laboratory tasks and real-life situations such as studying or following a healthy diet (e.g., Job et al., 2015; Bernecker & Job, 2015; see Francis & Job, 2018). Real-life associations between beliefs and behaviour have typically been observed during high self-control demands – for example, in university students during an exam period. Moreover, there is preliminary evidence that nonlimited self-control beliefs predict better subjective well-being through successful goal-striving (Bernecker et al., 2017). Finally, laboratory studies have shown that manipulating people's self-control beliefs towards a more nonlimited view improves their performance in self-control tasks, thus offering some evidence of causal effects. That said, more research is still needed before making strong causal claims (see Klinger et al., 2018; Li et al., 2024).

While these findings suggests that metacognitive beliefs may shape people's self-control performance, there are several noteworthy gaps in this line of research. Firstly, the

existing research has mostly limited itself to a single dimension of people's beliefs – whether they see self-control as a limited resource. Other potentially relevant differences in self-control beliefs have been largely ignored (although see Li et al., 2025). More specifically, there is little research on people's beliefs about how fixed versus malleable self-control is in the long-term. Yet, this has been the main question in research on beliefs concerning other psychological attributes, such as intelligence (see Dweck & Yeager, 2019). For instance, intervention studies suggest that believing in the long-term malleability of intelligence may lead to better academic achievement (Burnette et al., 2023; Hecht et al., 2021; but see Macnamara & Burgoyne, 2023).

Importantly, beliefs about the short-term limitedness and long-term malleability are conceptually distinct from each other. One could view self-control as a limited resource at any given situation and still believe that it can be trained in the long run, like muscle power (see Baumeister & Exline, 1999). Similarly, one may believe that one's capacity to exercise self-control is not depleted by acute self-control demands, but think that self-control is a fixed, stable trait like height. Examining both dimensions simultaneously would thus offer a more comprehensive view of people's metacognitive beliefs and might allow us to better understand how such beliefs are associated with behaviour (see Francis & Job, 2018). Indeed, preliminary evidence from consumer research already supports the idea that such a two-dimensional approach might be more informative (see Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010).

Secondly, extant research has not distinguished between people's beliefs about their own versus other people's self-control. Most studies have used scales that appear to primarily assess people's views of their own self-control. Examining such first-person beliefs is important, but it would seem equally relevant to assess how we reason about other people's self-control abilities. These beliefs may influence our judgments of other

people's behaviour in everyday situations (see Eme, 2016; Kennett, 2013; Koi, 2021). For example, we may view people's impulsive actions differently depending on how limited or fixed we believe their self-control abilities to be. Furthermore, our beliefs might also be informed by the characteristics of the other person in question. For example, Attention Deficit/Hyperactivity Disorder (ADHD) is a widely known neuropsychiatric diagnosis characterised by attention difficulties, hyperactivity, and impulsivity. These traits may cause additional challenges for self-control, and ADHD has even been characterised as the paradigmatic disorder of self-control (Eme, 2016; but see Koi, 2021). Thus, hearing that someone has an ADHD diagnosis could affect our beliefs about their self-control. However, to my knowledge, no study so far has empirically examined this possibility.

Thirdly, there is little research on whether and how self-control beliefs are associated with people's knowledge and use of different self-control strategies. Some researchers have suggested that viewing self-control as a nonlimited resource could encourage the use of a broad strategy repertoire (see Haimovitz et al., 2020). If one believes that exercising self-control does not lead to an acute depletion of self-control resources, one might be more likely to persist in the face of an extended motivational conflict and try out multiple different strategies to reach one's goal. However, the relationship may also be bidirectional. Equating self-control with a single intrapsychic process, such as effortful inhibition, could potentially underline beliefs about the limited and fixed nature of self-control – insofar as people view these types of psychological abilities as fixed traits relying on limited cognitive resources. By contrast, a multifaceted understanding of self-control, encompassing both intrapsychic and situational strategies, could foster nonlimited and malleable beliefs about self-control. Similar points have previously been raised with respect to intelligence beliefs, and research findings highlight

the importance of considering the definition of intelligence when assessing related beliefs about malleability (see Limeri et al., 2020; Sun et al., 2021a; 2021b).

1.3 Self-Control and Executive Function

The importance of situational strategies in everyday self-control does not mean that individual differences in top-down cognitive processes are irrelevant for understanding self-control performance. Executive function (EF) refers to top-down control mechanisms that enable goal-directed behaviour by modulating the operation of various cognitive subprocesses (Diamond, 2013; Miyake & Friedman, 2012; Zelazo, 2015). There are still open question concerning the exact structure and nature of EF (see Doebel, 2020; Karr et al., 2018), but it is typically understood to include components such as working memory, cognitive flexibility and inhibition. As noted above, research suggests that controlled tasks measuring EF do not strongly predict people's reports of their self-control success in their daily lives (Eisenberg et al., 2019; Saunders et al., 2018). An inherent limitation of the controlled task setting is that it does not capture the individual variation in people's environments and how they use situational strategies to shape those environments (Hofmann, 2024; Wennerhold & Friese, 2020). Thus, these tasks only capture a set of capacities (i.e., intrapsychic EF) affecting self-control success. By contrast, questionnaire measures of self-control tend to focus on real-life self-control outcomes. While self-rate measures have their own limitations (e.g., they rely on people's ability to accurately evaluate their self-control; see Jia et al., 2022), questionnaires are not restricted to measuring a fixed set of intrapsychic abilities. Hence, it is perhaps not surprising that empirical evidence suggests these measures may more consistently predict real-life outcomes (Eisenberg et al., 2019). Tasks aim to measure "pure" EF capacity at a single time point by controlling the influence of other factors, whereas questionnaires assess how people use these capacities to engage in self-control in real-life situations (Doebel, 2020;

Wennerhold & Friese, 2020). The latter requires aggregating multiple instances of behaviour, all coloured with numerous confounding intrapsychic and environmental factors.

Relatedly, it should be noted that EF tasks that have been used as measures of self-control typically imply a very different definition of self-control than most questionnaire measures (see Fujita et al., 2025). The most frequently used tasks – such as Stroop or Flanker tasks – require participants to inhibit a more automatic response tendency and redirect their attention to make the correct response. For example, in the Stroop task participants are shown colour words written in different colours and they must name the colour of the letters instead of reading the word. There is a clear conflict between automatic and more controlled processing, but the key question is to which extent this is a *motivational* conflict requiring self-control. Attentional control is also important when facing real-life self-control challenges (see Duckworth et al., 2016). However, from the perspective of personal motivation, struggling to focus on an important work project despite an urge to scroll social media appears quite different from following the instructions of an artificial cognitive task which requires inhibiting automatic responses.

Thus, in everyday self-control, EF works in close interaction with situational factors and people's personal motives. Yet it still has an important role in the equation. Even situational self-control strategies can be seen as indirectly intrapsychic (Duckworth et al., 2016). These strategies target circumstances outside our minds, but their benefits are based on how the relevant changes in our environment (e.g., quiet working place, social support, or the absence of tempting treats) affect our attention, cognitive appraisals and response tendencies. In this sense, situational strategies work by activating and deactivating intrapsychic mechanisms. While individual differences in EF do not dictate people's self-control success, they may affect how accessible and effective different self-control strategies are for a given person. For example, as noted earlier, ADHD is

characterised by various EF difficulties. We cannot conclude that strong ADHD traits therefore categorically impair self-control, but it seems plausible that attentional difficulties, impulsiveness and hyperactivity make certain intrapsychic self-control strategies less effective (Koi, 2021). By contrast, situational strategies, which support attentional control by reducing distraction and exogenously directing one's attention to goal-relevant things, might be more readily accessible. Yet this hypothesis remains to be empirically tested.

Understanding individual differences in self-control and supporting successful self-control performance therefore requires us to consider intrapsychic EF. Both task-based measures focusing on specific cognitive processes and questionnaire-based measures assessing real-life self-control are needed (Duckworth & Kern, 2011; see also Doebel, 2020). Indeed, existing research suggests that self-control beliefs are associated with both performance in EF tasks and self-control success in daily life (see Francis & Job, 2018). Thus, further research with controlled cognitive tasks can provide insights into whether and how metacognitive beliefs shape specific cognitive processes. For example, this approach allows us to examine whether self-control beliefs are associated with more efficient information processing at the level of specific EF subprocesses. On the other hand, questionnaire studies enable broader and more ecologically valid assessments of the role of metacognitive beliefs in complex self-control situations.

There is an interesting parallelism in some of the theories developed in research examining self-control and executive function, respectively. As discussed earlier, a recent theory proposes that self-control challenges should be understood as problems of regulatory scope (see Fujita et al., 2025). That is, self-control success requires the ability to address expansive considerations such as long-term health consequences or social commitments by overriding more contractive concerns apparent for oneself in the immediate environment. This view highlights the role of cognitive abstraction in modulating

regulatory scope (Fujita et al., 2025; Trope et al., 2021). Arguably, abstraction allows people to view single events and decisions as instances of a broader category or pattern, thereby expanding their regulatory scope. Any given action (e.g., opening a social media app in the middle of studying, ordering one more drink at a bar), is no longer merely an isolated event. One useful tool in such abstraction is language: words are symbolic representations that enable us to omit the context-dependent features of events and objects (Trope et al., 2021). In contrast to visual imagery and other types of sensory stimuli, words can allow us to treat specific instances of a given category as interchangeable. A “pint” is a “pint” whatever the shape of the glass, the type of the beer, or the milieu of the pub. Thus, language may help us to expand our regulatory scope. For example, preliminary evidence suggests that presenting foods as words promotes sensitivity to the effect a given food has on one's long-term health goals, while presenting foods as pictures promotes sensitivity to the food's taste (Carnevale et al., 2015).

Abstraction and language are also relevant in the context of EF. Many studies have investigated the role of language in working memory with a specific focus on inner speech – self-directed speech without audible articulation (see Alderson-Day & Fernyhough, 2015; Baddeley, 2012). This research has found that inner speech can support the short-term maintenance of information relevant to ongoing activities. However, verbal representations may also offer a more general processing advantage (Kompa & Mueller, 2020; Lupyan & Swingley, 2012). Language could be an efficient tool not only for maintaining task-relevant representations but also for updating and manipulating them (Kompa & Mueller, 2020). As in the regulatory scope theory, researchers have suggested that the key advantage of language from the perspective of EF is its relatively abstract nature. Omitting context-specific features may help to reduce cognitive load and make information processing more efficient. Thus, verbal representations may be useful tools both in solving motivational

conflicts requiring self-control and in more general-purpose cognitive processing. However, little empirical research has been conducted from this perspective.

1.4 The Present Dissertation

Motivational conflicts are ubiquitous in our daily lives and successful self-control has been linked to favourable long-term outcomes in terms of career, health, and social life (Allemand et al., 2019; Daly et al., 2015; Moffit et al., 2011). A comprehensive account of self-control is thus necessary for understanding people's paths in life and supporting their agency and well-being. Recent research on self-control highlights the role of metacognition, including metacognitive beliefs (Francis & Job, 2018; Hennecke & Bürgler, 2023; Li et al., 2024). However, there are some notable gaps in the current literature on this topic. This dissertation aims to broaden our knowledge of people's metacognitive beliefs about self-control, how these beliefs vary depending on individual characteristics, and how they relate to strategy use both in everyday self-control situations and at the level of EF subprocesses. Research on lay beliefs is an important step in uncovering the metacognitive mechanisms underlying self-control. Furthermore, knowledge about people's pre-existing beliefs can eventually provide valuable insights for behavioural public policy as well as science communication. Lay beliefs and knowledge about self-control and strategies can differ substantially from academic theories and research on the topic – and these differences might shape how people respond to evidence-based interventions programmes or science communication (see Bermúdez et al., 2023; Schuetze, 2022).

In this project, I assessed people's self-control beliefs with an adapted version of the self-report scale originally developed by Veronika Job and colleagues (2010). The original scale focuses on the degree to which people see self-control as a limited resource in the short term. In the present research, this scale was extended with an additional subscale which included items about the extent to which people see self-control as fixed in

the long term. In Chapter 2, I will report data from two studies which examined to what extent these two belief dimensions are relatively distinct from each other. These two studies also tested whether and how the scores on the self-control beliefs subscales were associated with conceptually related psychological phenomena: people's general self-esteem and self-efficacy, trait self-control, and beliefs about intelligence and personality. In both studies, beliefs about short-term limitedness and long-term malleability were relatively independent of each other. In addition, limitedness beliefs varied depending on the self-control domain. Self-control beliefs had weak-to-moderate correlations with self-esteem, self-efficacy, and trait self-control. Beliefs about the malleability of self-control were moderately associated with beliefs about the malleability of overall personality, but there was no correlation with beliefs about intelligence. These results support a multidimensional and domain-specific approach for measuring self-control beliefs.

Based on these findings, Chapter 3 further examines whether and how people's self-control beliefs depend on whose self-control they are thinking about and how information about an ADHD diagnosis affects these beliefs. This chapter presents the results of a questionnaire study in which I assessed people's beliefs about how limited and malleable their own self-control is, and then additionally asked about their beliefs about the self-control of fictional people with and without ADHD. This study also tested whether people's self-control beliefs were associated with their awareness and use of self-control strategies. Finally, I used questionnaire data to examine the possible differences in how people with and without ADHD rate the effectiveness and demandingness of different self-control strategies. The results suggest that people hold different views about the short-term limitedness and long-term malleability of self-control depending on whose self-control they are thinking about. One individual characteristic that affects these beliefs is an ADHD diagnosis: if people know that someone has ADHD, they are more likely to believe that this

person's self-control is a limited resource and a fixed trait. Moreover, this association between ADHD diagnosis and limitedness beliefs is even stronger in people who themselves have strong ADHD traits. By contrast, there was no consistent association between people's self-control beliefs and their knowledge and use of self-control strategies. People with strong ADHD traits rated all strategies as more demanding than those without strong ADHD traits. However, contrary to my hypothesis, the ADHD group found situational strategies slightly *less* effective than intrapsychic strategies, while the non-ADHD group showed an opposite pattern. In sum, the findings described in Chapter 3 illustrate the close interaction between neurocognitive traits, diagnostic categories, and metacognitive beliefs.

In Chapter 4, I will further discuss metacognition and strategy use, but this time focusing on specific EF subprocesses. I report the results of two studies which used a visual working memory task to examine the role of inner speech and verbal strategies in working memory maintenance and updating. In line with the hypothesis of a general processing advantage related to verbal representations, our findings suggest that the role of inner speech in working memory processing is not solely limited to information maintenance, but it may also support the efficient updating of task-relevant information. However, contrary to my expectations, self-control beliefs were not associated with cognitive performance in either of the studies. Nevertheless, a more nuanced understanding of the role of language in different EF subprocesses can inform our theories about how language mediates cognition and may eventually allow us to better support self-control of people with divergent or impaired EF capacity.

Finally, in Chapter 5, I will summarise the key methodological and conceptual contributions of the present dissertation and discuss the theoretical and practical implications of my research findings. I will integrate my results with earlier literature to

provide a more comprehensive picture of what research so far tells about self-control beliefs, strategy use, and EF – and which questions still require further examination.

Chapter 2 Measuring Self-Control Beliefs: A Multidimensional and Domain-Specific Perspective

In this first empirical chapter, I investigated the structure of self-control beliefs as well the construct and predictive validity of the self-control scales. In two questionnaire studies with adult UK participants, I examined the relation between short-term limitedness and long-term malleability beliefs. I also tested whether and how self-control beliefs were associated with measures of general self-esteem and self-efficacy, trait self-control, and malleability beliefs about other psychological phenomena.

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Measuring Self-Control Beliefs: A Multidimensional and Domain-Specific Perspective

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Declaration of Conflicting Interest

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Ethical Considerations

The research has been approved by the PPLS Research Ethics Committee, reference numbers: 7-2223/1 (Study 1) and 19-2425/1 (Study 2).

Consent to Participate

At the beginning of the online survey, the nature of the study was described, and participants were asked to indicate whether they agreed to participate in the study and whether they consent to the storage and use of their data. Participants gave their informed consent by ticking the box next to the response "Yes, I give my consent".

Data Availability Statement

The data described in this article are openly available in the Open Science Framework at

<https://www.doi.org/10.17605/OSF.IO/P9EQK>

Abstract

Self-control allows people to align their behaviour with intention in the face of a motivational conflict. Lay beliefs about self-control are associated with self-control performance. However, previous research has focused on whether self-control is seen as a limited resource in the short term and mostly ignored beliefs about whether self-control is malleable in the long term. We examined these two aspects of lay beliefs in two preregistered questionnaire studies with adult UK participants ($n_1=182$, $n_2=199$). In both studies, beliefs about the limitedness and malleability of self-control were relatively independent of each other. Moreover, limitedness beliefs varied depending on the self-control domain. Self-control beliefs were related to but relatively distinct from self-esteem, self-efficacy, and trait self-control. Beliefs about the malleability of self-control were moderately associated with beliefs about the malleability of overall personality, but not with beliefs about intelligence. Our results support a multidimensional and domain-specific approach when measuring self-control beliefs.

Keywords: self-control, willpower, metacognition, lay beliefs, implicit theories

In our daily lives, we are often faced with competing, contradictory motives: an urge to scroll through social media when we were planning to focus on writing an essay, an impulse to argue with a provoking relative although we wanted to enjoy a peaceful dinner together. These situations require *self-control* – that is, they require us to align our behaviour with a motivational commitment, such as an intention or better judgment, in the face of conflicting impulses or motives (Koi, 2021).

Self-control can be understood as *state*: our ability to deal with motivational conflicts varies depending on situational factors. We might refrain from opening a social media app and successfully finish our essay but still end up starting a family feud later in the evening. However, there also appears to be meaningful individual differences in people's general ability to exercise self-control across different situations (e.g., Allemand et al., 2019; Daly et al., 2015; de Ridder et al., 2012). From this perspective, self-control is a *trait* or *skill* (see Bermúdez, 2021; de Ridder et al., 2018). Individual differences in self-control predicts many important life outcomes such as physical health, subjective well-being, educational achievement, employment, and success in interpersonal relationships (e.g., Daly et al., 2015; de Ridder et al., 2012; Moffit et al., 2011).

Although traditional conceptions of self-control often emphasize effortful inhibition of unwanted behaviour, empirical evidence suggests that individual differences in self-control cannot be reduced to differences in effortful inhibition (Duckworth et al., 2016; Hofmann, 2024; Inzlicht & Friese, 2021; see also Eisenberg et al., 2019; Saunders et al., 2018). Many researchers have started to view self-control as an umbrella concept encompassing multiple strategies that do not rely on a shared psychological process or a single neural mechanism (e.g., Duckworth et al., 2016; Fujita et al., 2020; Milyavskaya et al., 2019; but see also Sripada, 2021). Importantly, this view of self-control encompasses situational strategies that rely on our physical, digital, and social surroundings. People who excel in

self-control are often actively shaping their environments to support their goal pursuit: avoiding places with noisy distractions, choosing paths with less temptations, and seeking out for social support (see Hofmann, 2024). At the same time, people's self-control success is constantly being shaped by contextual factors that they cannot control, from their immediate environments to broader sociocultural influences (Hofmann, 2024; Michaelson & Munakata, 2020).

Both situational self-control strategies and intrapsychic strategies, such as inhibition or cognitive reframing, serve the common goal of helping us to align our behaviour with our commitments when facing a motivational conflict (Koi, 2021). Indeed, the flexible use of a diverse strategy repertoire might be the most adaptive approach in dealing with self-control challenges (Bürgler et al., 2021; Hennecke & Bürgler, 2020). For example, when trying to focus on a tedious writing task, you can try to simply inhibit the urge to check your messages or scroll social media. Alternatively, you could leave your phone in a different room and temporarily turn off your internet connection.

Metacognitive Beliefs About Self-Control

A view that emphasises the heterogenous nature of self-control and the benefits of flexible strategy use also points to the importance of metacognition about self-control – that is, people's beliefs and knowledge about their own self-control and the self-control of others (Hennecke & Bürgler, 2022). If self-control is a broad toolkit, then people's success in self-control could in part depend on their beliefs and knowledge about the features of that toolkit. One of the metacognitive factors that may affect self-control behaviour are people's beliefs (or "implicit theories") about the nature of self-control (Francis & Job, 2018). While these beliefs are typically examined with explicit questionnaire items, the assessed beliefs are not expected to result from deliberative reasoning. Rather, it is assumed that people are usually not consciously reflecting on their beliefs or the effects these beliefs may have

on their behaviour (Bernecker et al., 2017). Yet, as these beliefs are expected to systematically inform people's reasoning and behaviour across different situations, measures used in this field assume that such lay beliefs can be assessed by asking people to rate their agreement with statements that reflect different views of self-control. A related assumption is that, despite situational variation, individual differences in these beliefs are relatively stable over time such that self-control beliefs can be meaningfully assessed as trait-like characteristics – although further longitudinal research is still needed on this matter (see Bernecker et al., 2017; de Ridder et al., 2020; Job et al., 2010).

Research on self-control beliefs has primarily focused on whether self-control is seen as a limited or nonlimited resource – that is, whether people believe that exercising self-control leads to a temporary shortage of self-control resources (see Francis & Job, 2018). A limited view of self-control is associated with poorer self-control performance in both laboratory tasks and real-life challenges such as studying or following a healthy diet (e.g., Bernecker & Job, 2015; see Francis & Job, 2018; Job et al., 2015). Moreover, nonlimited self-control beliefs also predict better subjective well-being through more successful goal-striving (Bernecker et al., 2017). These real-life associations have generally been observed during high self-control demands – for example, in university students when final exams are approaching (e.g., Bernecker et al., 2017; Job et al., 2015). Importantly, laboratory studies have shown that manipulating people's self-control beliefs can affect their performance in self-control tasks, offering preliminary evidence of causal effects (Haimovitz et al., 2020; Job et al., 2010; Miller et al., 2012; but see Klinger et al., 2018; Li et al., 2024).

Researchers measuring these beliefs have designed several subscales to focus on different self-control domains, such as continuing with tasks that require strenuous mental effort versus resisting temptations. In initial research, these subscales were combined to

form one general score (Job et al., 2010). However, more recent research suggests that limitedness beliefs might be domain-specific to some extent. That is, limitedness beliefs in different domains are not necessarily correlated with each other (Jędrzejczyk & Zajenkowski, 2020). Furthermore, focusing on the relevant self-control domain (e.g., resisting temptations or controlling emotions) may be important for detecting associations between beliefs and self-control behaviour (Bernecker & Job, 2017).

The Structure of Self-Control Beliefs

Existing research has focused on a single characteristic of people's beliefs – the extent to which they see self-control as a limited resource in the short term (but see Li et al., 2025 for a recent study with a more bottom-up approach). By contrast, studies have largely ignored the extent to which self-control is considered fixed versus malleable in the long-term – a question central to the research on beliefs about other psychological attributes, such as intelligence (see Dweck & Yeager, 2019). For example, intervention studies have suggested that beliefs about the long-term malleability of intelligence may lead to better academic achievement (Burnette et al., 2023; Hecht et al., 2021; but see Macnamara & Burgoyne, 2023). Limitedness and malleability beliefs are conceptually distinct from each other. For instance, one may view self-control as a limited resource at any given moment while still believing that it can be trained in the long run, like muscle power (see Baumeister & Exline, 1999). Similarly, it is possible to simultaneously believe that one's capacity to exercise self-control is not depleted by acute self-control demands and that self-control is a fixed, stable trait similar to height. Thus, measuring both dimensions simultaneously would offer a more comprehensive picture of people's metacognitive beliefs about self-control and allow a better understanding of how these beliefs are associated with everyday self-control (see Francis & Job, 2018).

Indeed, some preliminary evidence from consumer research supports this idea (Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010). For example, university students who saw self-control more as a nonlimited resource tended to make more consumption-related resolutions, but only if they also believed self-control to be malleable (Mukhopadhyay & Johar, 2005). Furthermore, compared to other parents, parents with strong limitedness *and* malleability beliefs tended to take their children less frequently to fast-food restaurants, give their children unhealthy snacks less often, and prefer educational to entertaining television programs for them (Mukhopadhyay & Yeung, 2010). While these studies found that beliefs about short-term limitedness (measured with items such as “I believe that people cannot hold themselves back beyond a point.”) and the long-term fixedness (i.e., lack of malleability ; e.g., “Everyone has a certain amount of self-control, and one can’t do much to change this amount.”) of self-control were positively correlated, these correlations were only weak to moderate in magnitude, suggesting that these beliefs are relatively independent of each other. Moreover, considering both dimensions separately allowed more nuanced predictions of people’s behaviour. However, these studies were conducted with very specific groups: university students and parents of young children. To our knowledge, people’s beliefs about the malleability of self-control have not been specifically studied after this initial work.

Studying this aspect of self-control beliefs would also allow comparisons between people’s beliefs about the malleability of self-control and their beliefs about the malleability of other psychological attributes, such as intelligence and personality. Earlier research has examined associations between people's beliefs about the malleability of various psychological phenomena (Dweck et al., 1995; Hughes, 2015; Schleider & Weisz, 2016; Spinath, 2003; Zhu et al., 2020). It appears that beliefs about attributes that are often considered as more stable traits – such as intelligence or personality – are moderately

correlated, but relatively domain specific. However, we are not aware of previous research that would have included self-control beliefs in such comparisons.

Associated Psychological Phenomena and Demographic Characteristics

Self-control beliefs have been measured with scales that ask participants to report their agreement with statements such as “After a strenuous mental activity, you feel energized for further challenging activities.” or “Your capacity to resist temptations is not limited. Even after you have resisted a strong temptation you can control yourself right afterwards.” (Job et al., 2010). Considering that persisting in strenuous mental tasks and resisting temptations are generally valued abilities in many cultures (see Fitouchi et al., 2023; Horstkötter, 2015; Oliviola, 2023), people’s responses could also reflect their general self-esteem or self-efficacy. Self-esteem refers to people’s general sense of how worthy they are as a person (see Donnellan et al., 2015; Rosenberg, 1965), whereas self-efficacy reflects people’s beliefs about their ability to deal with challenges and reach their personal goals (see Bandura, 1997; Luszczynska et al., 2005). To the extent that people think about their own self-control when filling in the self-control belief scales, their responses may be influenced by these more general self-related attitudes. Self-control beliefs were significantly but weakly correlated with self-efficacy such that a nonlimited view of self-control was associated with lower self-efficacy in a diverse Dutch community sample (de Ridder et al., 2020). However, most studies measuring people’s self-control beliefs have not tested the association between self-control-belief items and general self-related attitudes.

If self-control beliefs scales capture beliefs that are specific to self-control, how do they relate to people’s assessments of their own self-control? Studies have reported weak-to-moderate negative correlations between nonlimited beliefs of self-control and self-rated trait self-control (Bernecker et al., 2017; de Ridder et al., 2020; Job et al., 2015),

suggesting that although the scales are related to some degree, they still measure two distinct concepts. However, previous studies have not tested whether the same applies to beliefs about the malleability of self-control. As both theoretical reasoning and preliminary empirical evidence suggest that beliefs about long-term malleability may be distinct from beliefs about short-term limitedness, these two types of beliefs could also be differently associated with self-rated self-control capacity.

Finally, while much of the previous research has been conducted with university students, there is also some research on age-related differences in self-control beliefs. Two studies with relatively large adult samples with a broad age range from Germany and the US reported that older adults were less likely to view self-control as a limited resource (Job et al., 2018). These age-related differences in self-control beliefs were mediated by differences in perceived autonomy: older adults' stronger autonomous motivation appeared to promote nonlimited beliefs. The researchers suggested that the observed age-related differences in limitedness beliefs may have been driven by older adults' increased autonomy on strenuous tasks in their everyday life. That said, we are not aware of other studies that would have examined age-related differences in samples with a broad age range – or any studies that would have measured age-related differences in malleability beliefs.

Overview of the Studies

In sum, prior research has focused on whether self-control is seen as a limited resource and mostly ignored beliefs about the long-term malleability of self-control. Thus, there is a need for further information about how the two belief dimensions relate to each other. In the present studies, we examined the structure of people's self-control beliefs by adding a new subscale to the scale developed by Job and colleagues (2010), which has been the standard measure in this line of research. More specifically, in addition to

measuring whether self-control is seen as a limited resource, we measured the extent to which people see self-control as fixed versus malleable and how these two dimensions relate to each other. Furthermore, we investigated whether and how the scores on the self-control beliefs subscales are associated with people's general self-esteem and self-efficacy, self-rated trait self-control, and beliefs about intelligence and personality. We also tested whether there were age-related differences in self-control beliefs.

We had five key predictions. Firstly, we expected that adding a new subscale reflecting the malleability of self-control to the self-control beliefs scale previously used by Job and colleagues would yield a two-component structure consisting of two dimensions: (1) limited versus nonlimited and (2) malleable versus fixed (Studies 1 and 2). Secondly, we expected that the self-control beliefs are related but relatively distinct from self-esteem and self-efficacy. Thus, the self-control beliefs subscales should show moderate correlations with the Rosenberg Self-Esteem Scale (Rosenberg, 1965; Study 1) and self-efficacy as measured by the General Self-Efficacy Scale (Schwarzer & Jerusalem, 1995; Study 2). Thirdly, we expected to replicate the finding from previous studies that self-control beliefs would only have a weak to moderate correlation with the Trait Self-Control Scale (Tagney et al., 2004) as the scales are assumed to measure distinct concepts (Study 1). Fourthly, we expected that people's beliefs about the malleability of self-control will be positively correlated with their beliefs about the malleability of intelligence and personality as measured by the implicit theories scales (Dweck, 1999; Hughes, 2015) but that these correlations will be only weak-to-moderate (Study 2). Finally, we expected to replicate the earlier finding that age is positively associated with a nonlimited view of self-control (Studies 1 and 2).

Study 1

In study 1, we examined the structure of self-control beliefs by adding a new malleability-

versus-fixedness subscale to the scale previously used in this research. We also tested how these beliefs were associated with trait self-control and general self-esteem, as well as age and other demographic variables.

Method

Pilot Study

We first ran a pilot study to detect any potential practical issues with the questionnaire and to evaluate whether manipulating the wording of the self-control beliefs scale (i.e., referring to "willpower" versus "self-control", inclusion versus exclusion of phrases that strongly imply the ego depletion view on self-control) affected participants' responses. The scales used to measure self-control beliefs use the term "willpower" instead of "self-control" (see Francis & Job, 2018). Considering the strong connotation between "willpower" and power as in muscular strength or an energy resource (Koi, 2024), this choice of words could affect participants' judgements. Furthermore, in self-control literature, the term willpower has often been used to refer specifically to internal self-control in which effortful inhibition plays a central role (e.g., Duckworth et al., 2018; Fujita et al., 2020; Inzlicht & Friese 2021). That said, empirical evidence suggests that lay people may consider the terms willpower and self-control as relatively synonymous. (Bermúdez et al., 2021).

A pilot sample ($n=34$; $M_{Age}=18.8$, $SD=1.0$; 73.5% Female, 17.6% Male, 8.8% Other) was recruited using the student volunteer panel of a public research university in the United Kingdom. Each participant was randomly assigned to one of the two versions of the scale: (A) the original version or (B) an alternative version in which the term "willpower" was replaced with "self-control" and phrases that strongly implied the ego depletion view of self-control (e.g., "you must rest to refuel your energy") were replaced with arguably more neutral ones ("you must rest to recover").

When the results from the two versions of the scale were compared, there were no significant differences in the mean scores of any of the subscales (all p -values $\geq .33$; see Appendix 1) Moreover, participants also appeared to provide similar definitions for willpower and self-control when they were asked to explain these terms in their own words. Due to the limited size and unrepresentative nature of the pilot sample, this result does not allow any strong conclusions. However, in the absence of clear signs of wording-related differences, we decided to prioritise comparability with previous studies and only used the original willpower version of the scale in our main studies.

Participants

The final sample included 182 adults living in the United Kingdom. Participants were recruited via the Prolific online recruiting platform (see [Peer, 2024](#)) and received a monetary compensation of £2.50 for their participation. We set 50-50 quotas for men and women to avoid overrepresentation of one gender.¹ All data was collected in December 2022. Sample characteristics are reported in Table 1. Our sample had a broad age range (18–75) and was relatively diverse in terms of self-reported levels of education and income. Based on our a priori power analysis conducted with G*Power (Faul et al., 2007), the effect sizes reported in studies examining the effect of age on self-control beliefs (Job et al., 2018; $d = .30$ – $.35$), our sample size should yield a statistical power of 95% for detecting the effect of age. Additionally, our sensitivity analysis (similarly conducted with G*Power) suggests that the present sample size had 80% power to detect correlations of at least $|r| = .18$. Moreover, this sample size was sufficient for examining the self-control beliefs scale with a principal component analysis as there were 10 observations per each variable.

The questionnaire included a simple attention check item (“There is no actual statement here, this is just a simple attention check. Select all response options.”) that was

embedded in the self-control beliefs scale. One participant failed to provide a correct answer and was excluded from the final sample. In addition, 26 participants started the online questionnaire, but did not complete it and were therefore excluded. The exclusion criteria were preregistered before data collection.

Procedure

The questionnaire was implemented using Qualtrics online survey software. Participants filled in the original self-control beliefs scale by Job and colleagues (2010) about the limitedness of self-control, and our additional subscale about the malleability of self-control. Next, general self-esteem and self-rated trait self-control were measured with the Rosenberg Self-Esteem Scale and the Brief Trait Self-Control Scale, respectively. The order of the three scales was fixed, but items within each scale were presented in random order. Finally, participants were asked to report their age, gender, level of education, annual income, and political orientation. This demographic information was collected to estimate the diversity of our sample as well as to allow statistical analyses on associations between these characteristics and self-control belief. Apart from the age-related analyses, the analyses with demographic information were exploratory.

Measures

All measure items are presented in Appendix 2.

Table 1*Study 1 Sample Characteristics*

Age	Mean=43.9 (SD=14.4), Range=18–75
Gender	50.0% Male, 49.5% Female, 0.5% Other
English proficiency	92.9% Native/bilingual, 5.5% Advanced, 1.6% Intermediate
Time lived in the UK	87.9% Born in the UK, 8.8% More than 5 years, 2.7% 2–5 years, 0.5% Less than 2 years
Level of education	0.5% Primary, 18.7% Secondary, 22.5% Further, 41.8% Higher: Undergraduate Degree, 16.5% Higher: Postgraduate Degree
Annual income	26.9% Below £15 000, 30.2% £15 000–25 000, 23.1% £25 000–40 000, 15.4% £40 000–60 000, 4.4% Over £60 000
Political orientation (Left 0–Right 10)	Mean=4.1 (SD=2.1), Range 0–10

Self-Control Beliefs

Self-control beliefs were measured with three subscales, each of which included 6 statements. Participants had to rate each statement on a scale from 1 (“Strongly agree”) to 6 (“Strongly disagree”). Two of the subscales were from the original scales designed by Job and colleagues (2010), measuring how strongly participants endorse a limited view of self-control in the domain of strenuous mental effort (e.g., “After a strenuous mental activity, your energy is depleted, and you must rest to get it refuelled again.”) and resisting temptations (e.g., “Resisting temptations makes you feel more vulnerable to the next temptations that come along.”), respectively. Additionally, we included a new subscale to measure how strongly participants endorse a fixed versus malleable view of self-control (e.g., “Your willpower is something about you that you can’t change very much.”). We designed these new items based on the items used to measure implicit theories of intelligence (Dweck, 1999). The final score for each subscale was derived by calculating the mean of the item scores.

General Self-Esteem

General self-esteem was measured with the Rosenberg Self-Esteem Scale (Rosenberg, 1965, 1989). This scale has been extensively used in self-esteem literature for decades and has generally demonstrated good psychometric properties (e.g., Donellan, 2015; but see also Hubley et al., 2025). The scale includes 10 self-related statements (e.g., “I feel that I have a number of good qualities.”), which are rated on a scale from 1 (“Strongly agree”) to 4 (“Strongly disagree”). Each item is scored from 0 to 3, and the total score is calculated by adding the raw scores from each item.

Trait Self-Control

Trait self-control was measured with the Brief Self-Control Scale (Tangney et al., 2004; for

psychometric analyses, see Haktanir et al., 2024; Manapat et al., 2021). The scale comprises 13 self-control-related items (e.g., “I am able to work efficiently towards long-term goals.”), which are rated on a scale from 1 (“Not at all”) to 5 (“Very much”). Each item is scored from 1 to 5, and the total score is calculated by adding the raw scores from each item.

Demographic Information

In addition, participants were asked to provide information about their age, gender, English proficiency and how long they had lived in the UK, level of education, annual income, and political orientation (see Table 1).

Statistical Analyses

Statistical analyses were carried out following a preregistered analysis plan. All the analyses were conducted with R (R Core Team, 2022). The structure of self-control beliefs was examined with a principal component analysis (PCA). We opted for an exploratory PCA instead of a confirmatory factor analysis (CFA) because the latter assumes that the individual items are mutually uncorrelated after conditioning on the common factor and that the target constructs are equivalent to whatever is in common among all indicators, such that anything not shared among the items belongs to the residual (Rhemtulla et al., 2020). However, previous research with the self-control beliefs scale does not provide unambiguous evidence for either of these assumptions (Bernecker & Job, 2017; Jędrzejczyk & Zajenkowski, 2020; Napolitano & Job, 2018). Thus, we opted for an exploratory PCA instead of a CFA. The associations between the self-control beliefs subscales and self-esteem, trait self-control, and demographic variables were examined with correlation coefficients.²

Results

Self-Control Beliefs Subscales

As expected, there was considerable individual variation in participants' mean scores on self-control beliefs subscales (Table 2). Cronbach's alphas suggest good-to-acceptable internal consistency for all three subscales.

Table 2

Study 1 Self-Control Beliefs Subscales: Descriptive Statistics

Subscale	<i>M (SD)</i>	Range	Cronbach's α
Limitedness (ME)	3.95 (0.93)	1.33–6.00	.88
Limitedness (RT)	3.01 (0.74)	1.00–5.83	.76
Fixedness	2.50 (0.73)	1.00–4.67	.80

Note. ME=mental effort, RT=resisting temptation.

Partial correlations between the mean scores of the subscales did not support the hypothesis that there would be two dimensions reflecting beliefs about the fixedness (i.e., lack of malleability) and limitedness of self-control. Instead, one of the original limitedness subscales (resisting temptation) was moderately correlated with the other limitedness subscale (mental effort; $r=.42$, $p<.001$) and the fixedness subscale ($r=.42$, $p<.001$). Additionally, there was a weak negative correlation between the fixedness subscale and the mental-effort limitedness subscale ($r=-.16$, $p=.03$).

Principal Component Analysis

According to our assumption checks, the data was adequate for conducting a PCA (see Appendix 3). Eigenvalues and the parallel analysis suggested a model with four components. This model explained 66% of the total variance. For clarity of interpretation, a rotation was performed. As none of the pairwise correlations between components exceeded the cutoff score of .33 (all absolute values $<.001$), an orthogonal Varimax

rotation was performed. Rotated component loadings are presented in Table 3.

Two of the components corresponded to a specific subscale: all six mental-effort items loaded heavily on Component 1 and five of the six fixedness items loaded heavily on Component 2. The inconsistent fixedness item was also the only one that described the possibility of a negative change (“Some things you do can damage your self-control in the long term.”).

The remaining two components mainly captured different subsets of the resisting-temptation items, with reverse-scored items reflecting nonlimitedness beliefs (e.g., “If you have just resisted a strong temptation, you feel strengthened and you can withstand any new temptations.”) loading heavily on Component 3 and non-reverse-coded items reflecting limitedness beliefs (e.g., “Resisting temptations makes you feel more vulnerable to the next temptations that come along.”) loading heavily on Component 4. However, several mental-effort and fixedness items also have moderate loadings on these two components.

Association with Self-Esteem

The mean scores of the mental-effort ($r=-.30$, $p<.001$) and resisting-temptation ($r=-.31$, $p<.001$) subscales were moderately negatively correlated with general self-esteem. That is, stronger beliefs about the limitedness of self-control were associated with lower self-esteem regardless of the domain (i.e., exerting mental effort or resisting temptation). By contrast, the fixedness subscale was not correlated with general self-esteem ($r=-.09$, $p=.21$).

Table 3*Study 1 Varimax Rotated Component Matrix*

Item	Component 1	Component 2	Component 3	Component 4
Limitedness (ME) 1*	.78	.01	.34	.03
Limitedness (ME) 2*	.73	.04	.33	.01
Limitedness (ME) 3*	.72	.03	.44	-.05
Limitedness (ME) 4	.78	-.01	-.17	.21
Limitedness (ME) 5	.82	.06	-.13	.16
Limitedness (ME) 6	.78	-.02	-.01	.22
Limitedness (RT) 1*	.15	.14	.77	.11
Limitedness (RT) 2*	.17	.21	.77	.03
Limitedness (RT) 3*	-.06	.12	.67	.29
Limitedness (RT) 4	.00	.29	.33	.67
Limitedness (RT) 5	.35	.07	.27	.53
Limitedness (RT) 6	.19	.20	.13	.73
Fixedness 1*	.08	.70	.27	-.27
Fixedness 2*	-.25	.30	.16	-.46
Fixedness 3*	.07	.78	.29	-.06
Fixedness 4	.00	.73	.04	.46
Fixedness 5	.02	.89	.08	.17
Fixedness 6	-.04	.82	-.01	.30

Note. Loadings >.30 are in bold. Items marked with an asterisk were reverse-coded.

ME=mental effort, RT=resisting temptation.

Association with Trait Self-Control

Similarly, there was a moderate negative correlation between the trait self-control score

and the mean score on the two limitedness subscales. Weaker self-reported trait self-control was associated with stronger endorsements of the limited resource view of self-control in the domain of mental effort ($r=-.38, p<.001.$) and resisting temptation ($r=-.35, p<.001$). There was no significant correlation between the trait self-control score and the mean score on the fixedness subscale ($r=-.04, p=.60$).

Age-Related Differences

In contrast to the previous research, there were no significant associations between age and either the mental-effort ($r=-.07, p=.33$) or resisting-temptation ($r=-.12, p=.11$) subscales. Moreover, there was also no significant association between age and the fixedness subscale, with ($r=.05, p=.51$). We also conducted exploratory analyses on other potential demographic differences (See Appendix). However, we observed no significant correlations or group differences after controlling for multiple comparisons.

Summary

Study 1 provided support for the hypothesis that beliefs about the short-term limitedness and long-term malleability of self-control are relatively distinct from each other. In terms of mean scores, there was a moderate positive correlation between the fixedness subscale and resisting-temptation limitedness subscale, and a weak negative correlation between the fixedness subscale and the mental-effort limitedness subscale. In addition, the two limitedness subscales were moderately correlated with each other. The PCA further suggested that the limitedness and fixedness items were relatively independent of each other. Moreover, limitedness beliefs varied depending on the self-control domain and the positive versus negative wording of the items.

Both limitedness subscales were moderately associated with general self-esteem and self-rated trait self-control, suggesting that these scales measure related but distinct concepts. The fixedness subscale was not associated with either self-esteem or trait self-

control. Finally, in contrast to previous research, we did not find any age differences in self-control beliefs.

Study 2

Study 2 aimed to assess the robustness of the structure of self-control beliefs observed in Study 1 by replicating it in a second sample, and to test whether and how people's beliefs about self-control may be associated with their beliefs about intelligence and personality and their general self-efficacy.

Method

Participants

The final sample included 199 adults living in the United Kingdom. Three participants failed the attention check and were excluded from the final sample. In addition, seven participants started the online questionnaire without completing it and were thus excluded. As in Study 1, participants were recruited via the Prolific online recruiting platform and received a monetary compensation of £1.50.³ We again set 50-50 quotas for men and women to avoid overrepresentation of one gender. All data was collected in October 2024. Sample characteristics are reported in Table 4. Similar to Study 1, the sample had a broad age range (18–79) and was relatively diverse in terms of self-reported levels of education and income. The sample size was primarily decided based on monetary resources. However, with ≥ 10 observations per variable, the sample size was considered sufficient for a PCA of the self-control beliefs scale. Similar to Study 1, our sensitivity analysis with G*Power suggests that this sample size had 80% power to detect correlations of at least $|r| = .18$.

Table 4*Study 2 Sample Characteristics*

Age	Mean=40.8 (SD=13.7), Range=18–79
Gender	48.2% Male, 48.7% Female, 3% Other
English proficiency	91.5% Native/bilingual, 8.0% Advanced, 0.5% Beginner
Time lived in the UK	81.9% Born in the UK, 12.1% More than 5 years, 3.0% 2–5 years, 2.5% Less than 2 years
Level of education	14.1% Secondary, 26.1% Further, 40.2% Higher: Undergraduate Degree, 19.6% Higher: Postgraduate Degree
Annual income	22.1% Below £15 000, 18.6% £15 000–25 000, 36.2% £25 000–40 000, 15.6% £40 000–60 000, 7.5% Over £60 000
Political orientation (Left 0–Right 10)	Mean=4.3 (SD=2.2), Range 0–10

Procedure

The questionnaire was implemented using Qualtrics online survey software. Participants first filled in the scales measuring their beliefs about self-control, intelligence, and personality. The order in which these three scales were presented, as well as the order of items within each scale, was randomised. Next, general self-efficacy was measured with the General Self-Efficacy Scale (with a randomised item order). Finally, participants were asked to report their age, gender, level of education, annual income, and political orientation.

Measures

All measures items are presented in Appendix 2. For measuring self-control beliefs and gathering demographic information, we used the same items as in Study 1. Additionally, we included scales for measuring participants' beliefs about the malleability of intelligence and personality (Dweck, 1999; Hughes, 2015) as well as their general self-efficacy (Schwarzer & Jerusalem, 1995).

Intelligence Beliefs

The scale consisted of 8 items measuring people's beliefs about the malleability of intelligence (Dweck, 1999; Hughes, 2015). Similar to the self-control belief scale, participants rated statements on a six-point scale (from "Strongly Agree" to "Strongly Disagree"). Each item was scored from 1 to 6 and the final score is derived by calculating the mean of the item scores.

Personality Beliefs

The scale consisted of 8 items measuring people's beliefs about the malleability of people's character (Dweck, 1999; Hughes, 2015). Similar to the other scales described above, participants were presented with simple statements and use a six-point scale (from

"Strongly Agree" to "Strongly Disagree"). Again, each item was scored from 1 to 6 and the final score was derived by calculating the mean of the item scores.

General Self-Efficacy

The scale consisted of 10 items measuring self-efficacy (Schwarzer & Jerusalem, 1995; for validity studies, see Luszczynska et al., 2005; Scholz et al., 2002; Zhou, 2016).

Participants rate each statement on a four-point scale to indicate how well the statement applied to them (from 1 = "Not at all true" to 4 = "Exactly true"). The total score was calculated by finding the sum of all items.

Statistical Analyses

Statistical analyses were carried out with R (R Core Team, 2022), following a preregistered analysis plan. After examining the internal consistency of each self-control belief subscale and the correlations between their mean scores, we conducted a PCA to examine the structure of the whole scale.⁴ The associations between the self-control beliefs subscales and intelligence and personality beliefs, general self-esteem, and demographic variables were examined with correlation tests.

Results

Self-Control Beliefs Subscales

Participants' mean scores on self-control beliefs subscales are presented in Table 5. As expected, Cronbach's alphas suggest good-to-acceptable internal consistency for all three subscales and the partial correlations between the mean scores of the subscales were weak-to-moderate at their largest. As in Study 1, the resisting-temptation limitedness subscale was moderately correlated with the fixedness subscale ($r=.41, p<.001$). However, in contrast to Study 1, the correlation between the two limitedness subscales was not significant ($r=.14, p=.05$). Moreover, there was no significant correlation between the mental-effort limitedness subscale and the fixedness subscale ($r=.08, p=.27$).

Table 5*Study 2 Beliefs Scales: Descriptive Statistics*

Scale	<i>M</i> (<i>SD</i>)	Range	Cronbach's α
Self-Control			
Limitedness (ME)	4.14 (0.81)	2.33–6.00	.83
Limitedness (RT)	3.10 (0.77)	1.00–5.00	.77
Fixedness	2.74 (0.76)	1.00–5.33	.77
Fixedness (Intelligence)	3.05 (1.05)	1.00–5.63	.95
Fixedness (Personality)	3.30 (0.92)	1.00–5.13	.93

Note. ME=mental effort, RT=resisting temptation.

Principal Component Analysis

Based on our assumption checks, the data was adequate for a PCA (see Appendix 3).

Eigenvalues and the parallel analysis suggested a model with four components. This model explains 63% of the total variance. For clarity of interpretation, a rotation was performed. As none of the pairwise correlations between components exceeded the cutoff score of .33 (all absolute values $<.001$), an orthogonal Varimax rotation was performed.

Rotated component loadings are presented in Table 6.

As in Study 1, two of the components correspond to a specific subscale: all six mental-effort items loaded heavily on Component 1 and five of the six fixedness items loaded heavily on Component 2. Again, the only inconsistent fixedness item was the one describing the possibility of a negative change (“Some things you do can damage your self-control in the long term.”). Interestingly, in the present study, this item had a moderate negative loading on Component 1.

Table 6*Study 2 Varimax Rotated Component Matrix*

Item	Component 1	Component 2	Component 3	Component 4
Limitedness (ME) 1*	.80	.02	-.15	.17
Limitedness (ME) 2*	.62	-.05	-.12	.38
Limitedness (ME) 3*	.66	.20	-.24	.39
Limitedness (ME) 4	.75	.17	.20	-.07
Limitedness (ME) 5	.80	.08	.16	-.16
Limitedness (ME) 6	.73	.04	.26	-.17
Limitedness (RT) 1*	.05	-.02	.31	.72
Limitedness (RT) 2*	.04	.17	.26	.68
Limitedness (RT) 3*	.09	.25	.29	.57
Limitedness (RT) 4	.01	.23	.74	.21
Limitedness (RT) 5	.13	.06	.74	.09
Limitedness (RT) 6	.01	.19	.81	.16
Fixedness 1*	.09	.67	-.11	.46
Fixedness 2*	-.34	.09	-.25	.47
Fixedness 3*	.09	.75	-.07	.39
Fixedness 4	.01	.75	.23	.02
Fixedness 5	.13	.82	.24	.01
Fixedness 6	.06	.80	.19	.00

Note. Loadings >.30 are in bold. Items marked with an asterisk were reverse-coded.

ME=mental effort, RT=resisting temptation.

The results of Study 1 were further replicated as the remaining two components again mainly captured different subsets of the resisting-temptation items. Non-reverse-

scored items reflecting limitedness beliefs (e.g., “Resisting temptations makes you feel more vulnerable to the next temptations that come along.”) loaded heavily on Component 3 and reverse-coded items reflecting nonlimitedness beliefs (e.g., “If you have just resisted a strong temptation, you feel strengthened and you can withstand any new temptations.”) loaded heavily on Component 4. However, all reversed-coded fixedness items and two reversed-coded mental-effort items also had moderate loadings on Component 4.

Associations with Intelligence and Personality Beliefs

Stronger beliefs about the fixedness of self-control were associated with stronger beliefs about the fixedness of personality ($r=.36, p<.001$) and there was similarly a positive correlation between beliefs about the fixedness of personality and the beliefs about the fixedness of intelligence ($r=.49, p<.001$.) By contrast, there was no correlation between self-control beliefs and intelligence beliefs ($r=.04, p=.55$).

Interestingly, participants rated intelligence and personality as more fixed than self-control (see Table 5), as suggested by an exploratory analysis of variance, $F(2, 594)=18.14, p<.001, \eta^2=.06$. Mean fixedness ratings significantly increased across self-control (2.75), intelligence (3.05), and personality (3.30), all p -values $<.009$. False discovery rate correction was used in these comparisons. Removing the negative malleability item from the self-control beliefs scale did not change this pattern of results ([Appendix 5](#)).

Association with Self-Efficacy

As expected, self-control beliefs were associated with general self-efficacy, but the correlations were weak. There was a weak negative correlation between general self-efficacy and the mean score of the resisting-temptation limitedness subscale ($r=-.29, p<.001$), the fixedness subscale ($r=-.20, p=.005$), and the mental-effort limitedness subscale ($r=-.17, p=.02$). Thus, greater general self-efficacy was associated with a less

limited and more malleable view of self-control.

Age-Related Differences

Similar to Study 1, there were no significant associations between age and any of the self-control subscales after correcting for multiple comparisons (all p-values >.11).

Summary

Study 2 replicated the main findings of Study 1, thus further supporting a multidimensional and domain-specific view of self-control beliefs. The mean scores of the self-control belief subscales again suggested that malleability beliefs are relatively distinct from limitedness beliefs. The fixedness subscale was moderately correlated with the resisting-temptation limitedness subscale, but not with the mental-effort limitedness subscale. In contrast to Study 1, the limitedness subscales were not correlated with each other. The PCA results were very similar to Study 1, yielding four components which mostly reflected mental-effort limitedness items, fixedness items, non-reverse-coded resisting-temptation limitedness items, and reverse-coded resisting-temptation limitedness items, respectively.

All self-control belief subscales were moderately associated with general self-efficacy, suggesting that these scales measure something related to but distinct from self-efficacy. Beliefs about the malleability of self-control were moderately associated with beliefs about the malleability of overall personality, but not with beliefs about intelligence. Similar to Study 1, there were no significant age differences in self-control beliefs.

General Discussion

In these two studies, we examined the structure of people's self-control beliefs by adding a new subscale to the predominant measure in this line of research. Our results suggest that beliefs about the short-term limitedness and long-term malleability of self-control are indeed relatively independent of each other, but that limitedness beliefs may also be domain-specific. A more limited view of self-control was associated with lower self-esteem

and weaker self-rated trait self-control, but only moderately. Moreover, both limitedness and fixedness beliefs were associated with poorer self-efficacy. Interestingly, beliefs about the malleability of self-control were moderately associated with beliefs about the malleability of personality, but not with beliefs about the malleability of intelligence. Finally, in contrast to previous research, there were no age-related differences in self-control beliefs.

Multidimensional and Domain-Specific Beliefs

The distinction between limitedness and malleability beliefs could be observed both at the level of subscales and at the level of individual items. Firstly, we observed significant correlations between the mean scores of the subscales, but these were only weak-to-moderate in magnitude in both studies, suggesting the scales captured relatively distinct aspects of self-control beliefs. Secondly, in both studies, the PCA suggested a model with four components, two of which seemed to closely correspond to a specific subscale. The first component mainly captured variance related to the limitedness items related to mental effort and the second component mainly captured variance related to the fixedness items. The only inconsistent fixedness item was also the only item that expressed a possibility of negative long-term changes, suggesting a dissociation between lay beliefs about the possibility to improve versus damage one's self-control in the long term.

Our findings consistently support the hypothesis that limitedness and malleability beliefs are relatively distinct from each other. This highlights the need to measure both types of beliefs while conducting research on self-control. There is already preliminary evidence that beliefs about the malleability of self-control have behavioural implications (Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010). Moreover, a large body of research suggests that beliefs about the long-term malleability of other psychological attributes, such as intelligence, are associated with real-world outcomes (e.g., academic

achievement; see Dweck & Yeager, 2019). Hence, measuring malleability beliefs – which appear both conceptually and empirically distinct from limitedness beliefs – may well offer important insights to the role of metacognition in self-control behaviour.

The remaining two components from the PCA results are slightly more difficult to interpret, yet again similar across the two studies. In both studies, one component mainly contained high loadings from the reverse-coded resisting-temptation items, which expressed nonlimited views of self-control (e.g., “If you have just resisted a strong temptation, you feel strengthened and you can withstand any new temptations.”). By contrast, the remaining component contained high loadings from all the non-reverse-coded resisting-temptation items reflecting a limited view of self-control (e.g., “Resisting temptations makes you feel more vulnerable to the next temptations that come along.”). This finding resembles the results of an earlier study that combined several different US samples to examine the mental effort subscale using a factor analysis (Napolitano & Job, 2018). The analysis suggested that it might be useful to include a separate “method” factor to account for variance associated with reverse-coded items. However, in our data, this seemed to mainly be a concern for the items related to resisting temptation.

Somewhat surprisingly, the two subscales measuring limitedness beliefs in different self-control domains were also only moderately correlated with each other in Study 1. Furthermore, in Study 2, this correlation was not even significant – although it should be noted that this could be due to our limited statistical power for detecting weak correlations ($|r| = .18$). As described above, the PCA similarly suggested that resisting-temptation and mental-effort items mainly loaded on different components. Rather than holding a single, domain-general view of self-control, people appear to view the limits of self-control differently depending on the type of the motivational conflict. These results suggest that limitedness beliefs are relatively domain-specific. This is noteworthy, as previous studies

have sometimes combined the scores of different limitedness subscales to form a single dimension (e.g., Job et al., 2010). However, similar to our results, more recent studies have found limitedness beliefs to be domain-specific (Bernecker & Job, 2017; Jędrzejczyk & Zajenkowski, 2020).

Acknowledging this domain-specificity may allow researchers to increase prediction accuracy. For example, prior studies with Swiss participants found that people had different expectations about their self-control or willpower for exerting mental effort, resisting temptations, and controlling one's emotions (Bernecker & Job, 2017). Importantly, the role of these beliefs in predicting people's self-control behaviour was also domain specific. Thus, focusing on the relevant self-control domain can offer a better understanding of the links between metacognitive beliefs and self-control success.

One might even ask whether it makes sense to discuss "self-control beliefs" at a general level if people do not hold domain-general beliefs about self-control. That said, even if future research confirms that people's beliefs about self-control are profoundly domain-specific, there is a clear theoretical rationale for considering various distinct behaviours as self-control – as long as they involve self-regulation in the face of a motivational conflict (Koi, 2023; see also Fujita et al., 2025). While findings about the domain-specificity of people's beliefs should inform scale development and our understanding of how metacognitive beliefs relate to behaviour, this does not require us to abandon self-control as an umbrella concept.

In sum, our results support a multidimensional and domain-specific approach to measuring self-control beliefs. In addition to the distinction between beliefs about limitedness and malleability, there may be other important distinctions, such as between different self-control domains (i.e., continuing tasks requiring strenuous mental effort versus resisting temptation) and between beliefs in the possibility of a positive versus

negative long-term change. Taking these nuances into account enables us to better understand how lay people reason about self-control. These insights into people's metacognition about self-control, in turn, can eventually help us to better predict and support everyday self-control. For example, if studies consistently replicate the finding that self-control beliefs affect self-control behaviour, shaping these beliefs could be a way to support people's self-control. Findings about the multidimensional and domain-specific nature of self-control beliefs suggest that such intervention efforts should be carefully designed to cover the self-control belief dimensions and domains that are relevant to the self-control behaviour the intervention is designed to support.

Self-Control Beliefs, Self-Esteem, and Self-Efficacy

We also tested whether the self-control beliefs subscales measure something distinct from general self-esteem, self-efficacy and self-reported trait self-control. Stronger beliefs in the limitedness of self-control – regardless of the domain – were associated with lower self-esteem, poorer self-efficacy, and weaker trait self-control. Thus, limitedness beliefs are related to people's general feelings of self-worth and efficacy and their evaluations of their baseline self-control ability. As each of these constructs has also been linked to real-world behavioural outcomes (Hagger & Hamilton, 2024; Honicke & Broadbent, 2016; Muris & Otgaar, 2023), the present findings speak to the importance of studying self-control beliefs. At the same time, these correlations were only weak-to-moderate. This suggests that individual differences in people's scores on the limitedness subscales cannot be reduced simply to differences in self-evaluated trait self-control, self-esteem, or self-efficacy. Our findings are in line with previous studies on self-control beliefs, which have reported weak-to-moderate correlations with self-efficacy and trait self-control (Bernecker et al., 2017; de Ridder et al., 2020; Job et al., 2015). However, further research should be conducted to move beyond these broad descriptions and reach formal theories about the relations

between these phenomena and the potential interacting factors (e.g., the role of measurement instruments).

Malleability beliefs were also weakly associated with self-efficacy. Considering that self-efficacy is associated with important real-life outcomes such as academic performance (Honicke & Broadbent, 2016; Tsang et al., 2012), this finding further highlights the need to consider malleability beliefs in addition to limitedness beliefs. By contrast, there was no correlation between beliefs about the malleability of self-control and either general self-esteem or trait self-control. While this pattern of results was unexpected, it may be related to meaningful differences between the relevant concepts and measures. The scales we used to measure general self-esteem and trait-self-control include items that focus on people's general evaluations of *what kind of people they are* (e.g., "I feel I do not have much to be proud of.", "I am lazy."). By contrast, the General Self-Efficacy Scale is more exclusively focused on *what people think they can do* (e.g., "If I am in trouble, I can usually think of a solution."). Items referring to general problem-solving skills could be more closely linked to one's beliefs about their ability to change their self-control capabilities (e.g., "There are things you can do to improve your willpower."). Interestingly, some earlier work suggests that self-efficacy is more closely related to motivational constructs and self-esteem to affective constructs (Chen et al., 2004). Thus, if malleability beliefs are specifically related to self-efficacy, they might be especially relevant for motivational research focusing on topics such as work-related effort, performance, and achievement. That said, more research will be needed to test whether this finding can be replicated.

The Perceived Malleability of Different Psychological Phenomena

In Study 2, we found that beliefs about the malleability of self-control were moderately associated with similar beliefs about personality, but not with beliefs about

intelligence. Beliefs about personality and intelligence were also moderately associated with each other. Thus, while beliefs about the malleability of different psychological attributes are not fully independent, our results suggest that people do not hold generalized beliefs about the malleability of psychological phenomena. Rather, their views vary depending on which phenomenon they are thinking about – at least to some extent. This finding is in line with previous research (e.g., Hughes, 2015; Zhu et al., 2020). Still, the finding that only personality beliefs were correlated with self-control beliefs was unexpected. This may reflect the fact that the scale we used measures personality in very broad terms instead of focusing on any specific set of traits (e.g., “People can always substantially change the kind of person they are.”). Arguably, self-control and intelligence both contribute to “the kind of person one is”, which might explain why self-control and intelligence beliefs were associated with these types of overall personality beliefs, but not with each other. That said, it should be again noted that our sample size gave us only limited statistical power for detecting weak correlations ($|r| = .18$). Thus, the intercorrelations between malleability beliefs about different psychological phenomena should be further investigated with larger samples.

In our exploratory analyses, we observed that people viewed self-control as more malleable than intelligence or personality and that intelligence was rated as more malleable than personality. Other studies using these or similar scales have similarly found that people view intelligence as more malleable than overall personality (Hughes, 2015; Zhu et al., 2020; but see Spinath et al., 2003). A possible interpretation of the present pattern of findings is that people view specific characteristics and abilities, such as self-control and intelligence, as relatively malleable, but are somewhat more sceptical when it comes to changing one’s “most basic qualities” or the “kind of person one is”. However, future research should further test this hypothesis. Moreover, other factors not examined

here, such as the extent to which the public understanding of different psychological phenomena highlights neurobiology, may also shape malleability beliefs (see Lebowitz & Appelbaum, 2019; O'Connor & Joffe, 2013).

It should be noted that our measure for malleability beliefs about self-control differed from the other two malleability scales in one important respect: it included an item which referred to the possibility of negative change (“Some things you do can damage your self-control in the long term.”). Moreover, the PCA results suggested that this item functioned distinctly from the other items of the same subscale. Removing this item from our analyses did not affect the overall pattern of results. However, future studies could use a larger pool of negative malleability items to test whether people’s beliefs about negative versus positive malleability beliefs are in fact relatively independent of each other – and whether this depends on the psychological phenomenon they are thinking about. This also applies to our scale development more generally: malleability scale could be reconstructed starting with a larger pool of items that would explicitly cover different self-control domains (e.g., mental effort, resisting temptation, emotion regulation).

The Missing Age-Related Differences

Finally, in contrast to previous research (Job et al., 2018), we did not find any evidence of age-related differences in self-control beliefs. In the earlier studies with German and US participants self-control beliefs were associated with age such that older adults were more likely to endorse nonlimited beliefs. It is hard to find a simple explanation for this null finding. Based on the effect size estimates reported in the earlier research, our sample sizes should have yielded a statistical power of 95% for detecting the effect of age. Moreover, the age distribution of the present studies does not differ dramatically from the earlier study with German participants.

Strengths and Limitations

To our knowledge, the present studies are the first ones to examine lay beliefs about both the limitedness and malleability of self-control in a diverse sample of adult participants. This design allowed us to gather valuable information about the multidimensional structure of self-control beliefs. Yet, our study is not without its limitations.

Firstly, we relied on a limited set of multiple-choice items. While we analysed our data using a PCA without a predefined assumption of the structure of self-control beliefs, our measure inherently limits the type of information we were able to collect. Since we wanted our studies to map onto existing research, we built on existing scales (Job et al., 2010). However, some of our item choices could be seen as controversial given the debate about the scope of the concept of self-control (Bermúdez, 2021; Goschke & Job, 2023; Koi 2021). For example, on skill-based accounts of self-control, strenuous mental activity is not a paradigmatic dimension of self-control. The items used were also heavily reliant on the willpower metaphor (e.g., “After a strenuous mental activity, your energy is depleted, and you must rest to get it refuelled again.”). Our initial pilot study showed no difference for a less metaphorical phrasing, but the existence of such an effect cannot be completely ruled out. More generally, research published after our data collection suggests that when more open-ended questions are used, people’s self-control beliefs appear even more multidimensional (Li et al., 2025). Thus, future studies could combine quantitative and qualitative methods to allow a more comprehensive exploration of self-control beliefs.

Secondly, our results do not allow strong conclusions about *whose* self-control people are thinking about when filling in the scale. Do people’s responses reflect their beliefs about the limitedness and malleability of their own self-control or is the scale capturing more general beliefs about self-control? Research on lay beliefs has generally been somewhat vague in this regard. When research is conducted in English, scales often

use items that are phrased from an ambiguous second-person perspective and researchers do not always state whether they are interested in people's beliefs about a given attribute in general or about their personal attributes. Some studies on beliefs about intelligence have examined this issue (e.g., De Castella & Byrne, 2015; Gunderson et al., 2017). For example, a study with Australian high school students reported that a scale that was explicitly focused on participants' views of their own intelligence was a better predictor of their motivation and grades than a scale using more ambiguous second-person phrases. (De Castella & Byrne, 2015). Thus, people may interpret second-person items as statements about human nature in general and their evaluations of the nature of their own psychological attributes might be more relevant when predicting real-world outcomes.

Thirdly, our studies did not include a measure of everyday self-control behaviour. Thus, while limitedness and malleability beliefs appeared to be relatively distinct from each other in lay thinking about self-control, it is still an open question whether assessing malleability beliefs in addition to limitedness beliefs will allow better predictions of people's behaviour. Although there is preliminary evidence supporting this hypothesis (Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010), future studies should test the predictive validity of the multidimensional model suggested here.

Finally, we did not assess the stability of self-control beliefs. Previous research on self-control beliefs has largely assumed these beliefs to be relatively stable over time. However, to our knowledge, only a few studies have empirically tested this assumption (see [Bernecker et al., 2017](#); [de Ridder et al., 2020](#); [Job et al., 2010](#)). More research is therefore needed on the short- and long-term temporal dynamics of these beliefs. For example, studies could use ecological momentary assessment methods to explore whether and how self-control beliefs fluctuate in interaction with daily events (see [van den Bekerom et al., 2025](#); [Shiffman et al., 2008](#)). This general limitation of our cross-sectional

approach also applies to the measurement of other psychological phenomena, such as self-efficacy and self-reported self-control (see [de Ridder et al., 2020](#); [Ouweneel et al., 2013](#)). That said, single-time-point measures of self-control beliefs do predict self-control behaviour and real-life outcomes (see [Francis & Job, 2018](#)). Thus, while this approach does not tell the whole story, it nevertheless provides meaningful insights into people's beliefs and behaviour.

A better understanding of lay beliefs about self-control could eventually inform science communication and intervention development. Lay beliefs and knowledge about psychological concepts can differ from researchers' beliefs and knowledge (Bermúdez et al., 2021; Warne & Burton, 2020). This, in turn, may shape how they respond to science communication or intervention initiatives (see Schuetze, 2022). For example, there is some evidence that teachers' evaluations of the effectiveness of educational interventions and their use of such interventions may be associated with their pre-existing beliefs about intelligence and education (Schuetze, 2022; Warne & Burton, 2020). Similarly, lay beliefs about self-control might play a role in how effective people perceive different self-control strategies to be and how committed they are to follow an intervention designed to support self-control.

Conclusion

Our findings support a multidimensional and domain-specific approach when measuring self-control beliefs and suggest that these beliefs are related to but nevertheless distinct from general self-esteem, self-efficacy, and self-rated trait self-control, as well as beliefs about intelligence and personality. Our results also raise questions about how robust the previously reported age-related differences in self-control beliefs are. Further research should be conducted to test the robustness of our findings and examine whether different belief dimensions are also differentially associated with self-control behaviour. Eventually,

a more comprehensive model of lay beliefs about self-control can allow us to better understand the metacognitive mechanisms underlying everyday self-control. Moreover, intervention design and science communication in this field can also benefit from considering people's pre-existing beliefs. In a society where people are often bombarded with competing impulses, self-control research may help us to build environments that allow people to live up to their commitments amid motivational conflicts.

Footnotes

1. The binary 50-50 recruiting quotas for men and women limit the generalizability of our findings by potentially excluding some non-binary participants. That said, our samples include some participants whose gender status in Prolific was either male or female, but who identified as non-binary in our questionnaire. In any case, quantitative research on non-binary people's self-control beliefs would require considerably larger sample sizes or more targeted recruiting. As gender differences were not the focus of the present studies, we prioritised avoiding substantial female or male overrepresentation.
2. In our original preregistered analysis plan, self-esteem items were included in the PCA. However, given that our sample size was not sufficient for conducting PCA with such a large number of variables, we decided to examine the association between self-esteem and self-control belief scales with separate correlation tests.
3. The monetary compensation was smaller in Study 2 because the total duration needed for completing the questionnaires was estimated to be shorter.
4. In our preregistered analysis plan, we stated that if the results would have supported a clear structure with distinct factors for each subscale, the PCA would have been followed by a confirmatory factor analysis. However, although our scale had three subscales, the results of the PCA consistently suggested a four-

component solution as the resisting-temptation limitedness items loaded on two different components (reversed vs non-reversed items). Moreover, many scale items had notable loadings on more than one component. Thus, the PCA results did not support a clear factor structure for a CFA.

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Appendix 1: Pilot Study

Participants

The pilot sample consisted of 34 undergraduate students (Table S1).

Table A1

Pilot Sample Characteristics

Age	Mean=18.8 (SD=1.0), Range=17–21
Gender	73.5% Female, 17.6% Male, 8,8% Other
English proficiency	73.5% Native/bilingual, 23.5% Advanced, 2.9% Intermediate
Time lived in the UK	41.2% Born in the UK, 14.7% More than 5 years, 5.9% 2–5 years, 32.4% Less than 2 years

Results

No significant differences between the two versions (“willpower” versus “self-control”) of limitedness in the domain of mental effort ($M_{\text{willpower}}= 4.63$ vs $M_{\text{self-control}}= 4.50$; $t(23.39)=-0.61$, $p=.55$), limitedness in the domain of resisting temptation ($M_w= 3.32$ vs $M_s= 3.54$, $t(31.98)=0.98$, $p= .33$) or fixedness ($M_w= 2.59$ vs $M_s= 2.49$, $t(27.60)=-0.41$, $p= .69$) subscales. Furthermore, the pilot study suggested that the new subscale that we designed to measure malleability beliefs showed acceptable internal consistency (Cronbach's $\alpha=.77$)

and that there was a meaningful amount of variation in people's responses with scores ranging from 1 to 4 on a six-point scale ($M=2.53$, $SD=0.71$).

Appendix 2: Questionnaires

Self-Control Beliefs (Willpower Version)

This questionnaire has been designed to investigate your ideas about willpower. Willpower is what you use to resist temptations, to stick to your intentions, and to remain in strenuous mental activity. There are no right or wrong answers. We are interested in your ideas.

Using the scale below, please indicate how much you agree or disagree with each of the following statements.

Strongly agree
Moderately agree
Slightly agree
Slightly disagree
Moderately disagree
Strongly disagree

[Limitedness (ME) 1] When you have been working on a strenuous mental task, you feel energized and you are able to immediately start with another demanding activity.

[Limitedness (ME) 2] Your mental stamina fuels itself. Even after strenuous mental exertion, you can continue doing more of it.

[Limitedness (ME) 3] After a strenuous mental activity, you feel energized for further challenging activities.

[Limitedness (ME) 4] Strenuous mental activity exhausts your resources, which you need to refuel afterwards (e.g., through taking breaks, doing nothing, watching television, eating snacks).

[Limitedness (ME) 5] After a strenuous mental activity, your energy is depleted, and you must rest to get it refuelled again.

[Limitedness (ME) 6] When you have completed a strenuous mental activity, you cannot start another activity immediately with the same concentration because you have to recover your mental energy again.

[Limitedness (RT) 1] If you have just resisted a strong temptation, you feel strengthened and you can withstand any new temptations.

[Limitedness (RT) 2] Resisting temptations activates your willpower and you become even better able to face new upcoming temptations.

[Limitedness (RT) 3] Your capacity to resist temptations is not limited. Even after you have resisted a strong temptation you can control yourself right afterwards.

[Limitedness (RT) 4] Resisting temptations makes you feel more vulnerable to the next temptations that come along.

[Limitedness (RT) 5] When situations accumulate that challenge you with temptations, it gets more and more difficult to resist the temptations.

[Limitedness (RT) 6] It is particularly difficult to resist a temptation after resisting another temptation right before.

[Fixedness 1] There are things you can do to improve your willpower.

[Fixedness 2] Some things you do can damage your willpower in the long term.

[Fixedness 3] Your willpower is something about you that you can learn to change.

[Fixedness 4] You have a certain amount of willpower and you can't really do much to change it.

[Fixedness 5] Your willpower is something about you that you can't change very much.

[Fixedness 6] You can learn new things, but you can't really change your willpower.

[Attention Check] There is no actual statement here, this is just a simple attention check.

Select all response options.

Self-Control Beliefs (Self-Control Version)

This questionnaire has been designed to investigate your ideas about self-control. Self-control is what you use to resist temptations, to stick to your intentions, and to remain in strenuous mental activity. There are no right or wrong answers. We are interested in your ideas. Using the scale below, please indicate how much you agree or disagree with each of the following statements.

Strongly agree
Moderately agree
Slightly agree
Slightly disagree
Moderately disagree
Strongly disagree

[Limitedness (ME) 1] When you have been working on a strenuous mental task, you feel refreshed and you are able to immediately start with another demanding activity.

[Limitedness (ME) 2] Your mental stamina recovers itself. Even after strenuous mental exertion, you can continue doing more of it.

[Limitedness (ME) 3] After a strenuous mental activity, you feel refreshed for further challenging activities.

[Limitedness (ME) 4] Strenuous mental activity exhausts you, and you need to recover afterwards (e.g. through taking breaks, doing nothing, watching television, eating snacks).

[Limitedness (ME) 5] After a strenuous mental activity, you are tired and you must rest to recover.

[Limitedness (ME) 6] When you have completed a strenuous mental activity, you cannot start another activity immediately with the same concentration because you have to recover your mental stamina again.

[Limitedness (RT) 1] If you have just resisted a strong temptation, you feel strengthened and you can withstand any new temptations.

[Limitedness (RT) 2] Resisting temptations activates your self-control and you become even better able to face new upcoming temptations.

[Limitedness (RT) 3] Your capacity to resist temptations is not limited. Even after you have resisted a strong temptation you can control yourself right afterwards.

[Limitedness (RT) 4] Resisting temptations makes you feel more vulnerable to the next temptations that come along.

[Limitedness (RT) 5] When situations accumulate that challenge you with temptations, it gets more and more difficult to resist the temptations.

[Limitedness (RT) 6] It is particularly difficult to resist a temptation after resisting another temptation right before.

[Fixedness 1] There are things you can do to improve your self-control.

[Fixedness 2] Some things you do can damage your self-control in the long term.

[Fixedness 3] Your self-control is something about you that you can learn to change.

[Fixedness 4] You have a certain capability for self-control, and you can't really do much to change it.

[Fixedness 5] Your self-control is something about you that you can't change very much.

[Fixedness 6] You can learn new things, but you can't really change your self-control.

[Attention Check] There is no actual statement here, this is just a simple attention check.

Select all response options.

Rosenberg Self-Esteem Scale

Below is a list of statements dealing with your general feelings about yourself. Please indicate how strongly you agree or disagree with each statement. There are no right or wrong answers.

I feel that I'm a person of worth, at least on an equal plane with others.

Strongly agree

Agree

Disagree

Strongly disagree

I feel that I have a number of good qualities.

All in all, I am inclined to feel that I am a failure.

I am able to do things as well as most other people.

I feel I do not have much to be proud of.

I take a positive attitude toward myself.

On the whole, I am satisfied with myself.

I wish I could have more respect for myself.

I certainly feel useless at times.

At times I think I am no good at all.

Brief Self-Control Scale

Using the scale provided, please indicate how much each of the following statements reflects how you typically are.

I am good at resisting temptation.

1 Not at all	2	3	4	5 Very much
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I have a hard time breaking bad habits.

I am lazy.

I say inappropriate things.

I refuse things that are bad for me.

I wish I had more self-discipline.

People would say that I have iron self-discipline.

Pleasure and fun sometimes keep me from getting work done.

I have trouble concentrating.

I am able to work efficiently towards long-term goals.

Sometimes I can't stop myself from doing something, even if I know it is wrong.

I often act without thinking through all the alternatives.

Background Information

Next, we will ask you to provide some background information about yourself.

Age in years

Gender

Male

Female

Other

Prefer not to say

English proficiency

Beginner

Intermediate

Advanced

Native/bilingual

How long have you lived in the UK?

Less than 2 years

2–5 years

More than 5 years

Since I was born

What is the highest level of education you have completed?

Primary

Secondary

Further

Higher: Bachelor's Degree

Higher: Master's Degree

Higher: PhD

Which of the following best describes your personal income last year (before taxes)?

Below £15 000

£15 000–25 000

£26 000–40 000

£40 000–60 000

Over £60 000

In politics people sometimes talk of “left” and “right”. Where would you place yourself on this scale, where 0 means the left and 10 means the right?

Left
0

1

2

3

4

5

6

7

8

9

Right
10

Refusal

Don't
Know

Intelligence Beliefs

Below are a series of questions regarding your opinions and beliefs about intelligence.

Please complete this questionnaire by reporting your agreement with the statements below

You have a certain amount of intelligence and you really can't do much to change it.

Strongly agree	Agree	Mostly agree	Mostly disagree	Disagree	Strongly disagree
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People can substantially change their intelligence.

No matter what level of intelligence someone has, they can always change it very much.

Your intelligence is something about you that you can't change very much.

You can learn new things, but you can't really change your basic intelligence.

People can change even their most basic abilities.

As much as I hate to admit it, you can't really teach an old dog new tricks. People can't really change their basic level of intelligence.

Everyone, no matter who they are, can significantly change their basic level of intelligence.

Personality Beliefs

Below are a series of questions regarding your opinions and beliefs about people's personalities. Please complete this questionnaire by reporting your agreement with the statements below.

The kind of person someone is, is something very basic about them and it can't be changed very much.

Strongly agree	Agree	Mostly agree	Mostly disagree	Disagree	Strongly disagree
----------------	-------	--------------	-----------------	----------	-------------------

People can do things differently, but the important parts of who they are can't really be changed.

Everyone, no matter who they are, can significantly change their basic characteristics.

As much as I hate to admit it, you can't teach an old dog new tricks. People can't really change their deepest attributes.

People can always substantially change the kind of person they are.

Everyone is a certain kind of person, and there is not much that can be done to really change that.

No matter what kind of person someone is, they can always change very much.

All people can change even their most basic qualities.

General Self-Efficacy

Next, we will ask you about your views about your efficacy. Please rate the statements below according to how well you think they describe you.

I can always manage to solve difficult problems if I try hard enough.

Not at all true

Hardly true

Moderately true

Exactly true

If someone opposes me, I can find the means and ways to get what I want.

It is easy for me to stick to my aims and accomplish my goals.

I am confident that I could deal efficiently with unexpected events.

Thanks to my resourcefulness, I know how to handle unforeseen situations.

I can solve most problems if I invest the necessary effort.

I can remain calm when facing difficulties because I can rely on my coping abilities.

When I am confronted with a problem, I can usually find several solutions.

If I am in trouble, I can usually think of a solution.

I can usually handle whatever comes my way.

Appendix 3: PCA Assumption Checks

Study 1

Bartlett's test of sphericity suggested that the item correlations clearly differed significantly from zero, $\chi^2(153, N = 182) = 1540.871, p < .001$. Kaiser-Meyer-Olkin test of sampling adequacy yielded an adequate overall value of .85 and values for individual items were

ranging from .67 to .90. The correlation matrix showed that there was an appropriate amount of variability with some correlations being high and others close to zero. The determinant of the correlation matrix was positive, but extremely small (0.0001), suggesting that there might be redundant dimensions.

Study 2

Bartlett's test of sphericity suggested that the item correlations clearly differed significantly from zero, $\chi^2 (153, N = 199) = 1456.477, p < .001$. Kaiser-Meyer-Olkin test of sampling adequacy yielded an adequate overall value of .81 and values for individual items were ranging from .67 to .87. The correlation matrix showed that there was an appropriate amount of variability with some correlations being high and others close to zero. The determinant of the correlation matrix was positive, but extremely small (0.0005), suggesting that there might be redundant dimensions.

Appendix 4: Testing for Demographic Differences in Self-Control Beliefs

Study 1

Gender differences in self-control beliefs were examined with Student's t-test. There were no significant gender differences in the mean scores on self-control beliefs subscales (all p-values $\geq .21$).

Spearman's rank correlation coefficient was used to test the association between self-control beliefs subscales and the rank variables – namely, the levels of education and income. Self-control beliefs were also not associated with the level of education (all p-values $\geq .28$). There was a weak negative correlation between the level of income and the mean score of the mental-effort subscale ($\rho = -.16, p = .03$). The other subscales did not correlate with the level of income (all p-values $\geq .47$).

Finally, the association between self-control beliefs subscales and political orientation was tested with Pearson's correlation coefficient. Political orientation was

weakly correlated with the mental-effort and the fixedness subscales. More right-leaning participants were less likely to view willpower in the domain of mental effort as a limited resource ($r=-.16$, $p=.03$) and as fixed ($r=.20$, $p=.01$). However, none of these correlations between self-control beliefs and income or political orientation remained significant after false discovery rate correction for multiple comparisons.

Study 2

Based on our findings from Study 1, we also tested whether there are any associations between the self-control belief subscales and self-reported political orientation or the level of income. There were no significant correlations between these two variables and any of the self-control belief subscales (all p -values $>.18$).

Appendix 5: Associations with Intelligence and Personality Beliefs (Without Negative Malleability)

Study 2

Since only the self-control beliefs subscale included an item reflecting negative malleability, we also conducted the analysis comparing the malleability scales without this item. Again, stronger beliefs about the fixedness of self-control were associated with stronger beliefs about the fixedness of personality ($r=.37$, $p<.001$) and there was similarly a positive correlation between beliefs about the fixedness of personality and the beliefs about the fixedness of intelligence ($r=.47$, $p<.001$.) By contrast, there was no correlation between self-control beliefs and intelligence beliefs ($r=.07$, $p=.37$).

The differences in mean scores also remained the same. Participants rated intelligence and personality as more fixed than self-control (see Table S2), as suggested by an exploratory analysis of variance, $F(2, 594)=19.63$, $p<.001$, $\eta^2=.06$. Mean fixedness ratings significantly increased across self-control (2.70), intelligence (3.05), and personality (3.30), all p -values $<.01$. False discovery rate correction was used in these comparisons.

Study 2 Beliefs Scales: Descriptive Statistics (Without Negative Malleability)

Scale	<i>M</i> (<i>SD</i>)	Range	Cronbach's α
Self-Control			
Limitedness (ME)	4.14 (0.81)	2.33–6.00	.83
Limitedness (RT)	3.10 (0.77)	1.00–5.00	.77
Fixedness (5 items)	2.70 (0.86)	1.00–6.00	.85
Fixedness (Intelligence)	3.05 (1.05)	1.00–5.63	.95
Fixedness (Personality)	3.30 (0.92)	1.00–5.13	.93

Note. ME=mental effort, RT=resisting temptation.

In this chapter, I have reported the results of two studies on lay beliefs about self-control. My findings support a multidimensional and domain-specific approach when measuring self-control beliefs. In particular, beliefs about the limitedness and malleability of self-control are relatively independent of each other, and limitedness beliefs vary depending on the self-control context.

The results further suggest that self-control beliefs are related to but nevertheless distinct from general self-esteem, self-efficacy, and self-rated trait self-control. Interestingly, beliefs about the malleability of self-control are moderately associated with beliefs about the malleability of overall personality, but not with beliefs about intelligence.

A more comprehensive model of self-control beliefs can eventually allow us to better understand the metacognitive processes underlying everyday self-control.

Moreover, intervention design and science communication in this field can benefit from considering people's pre-existing beliefs.

However, open questions remain about whether lay beliefs depend on *whose* self-control people are thinking about and whether and how the suggested self-control belief dimensions are associated with people's knowledge and use of different self-control strategies in everyday situations. Next chapter will address these questions.

Chapter 3 Fixed and Limited: Lay Beliefs About Self-Control and ADHD

In this chapter, I will focus on whether people's self-control beliefs differ. In a questionnaire studies with two groups of adult UK participants - with and without ADHD - I test whether people express different views about self-control when thinking about their own self-control, the self-control of a fictional neurotypical person or the self-control of a fictional person with ADHD I also examine people's knowledge and use of intrapsychic and situational strategies, as well as their perceptions of the effectiveness and demandingness of these strategies.

This chapter has been written up for publication as *Fixed and Limited: Lay Beliefs About Self-Control and ADHD* by Anssi Bwalya, Polaris Koi, Nicolas Chevalier, and Hugh Rabagliati.

Fixed and Limited: Lay Beliefs about Self-Control and ADHD

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Data Availability

The preregistration, materials, data, and analysis code of the present studies are available in the Open Science Framework at: <https://doi.org/10.17605/OSF.IO/JHSV7>

Declaration of Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethics Approval Statement

The research has been approved by the PPLS Research Ethics Committee (reference numbers: 287-2324/1 and 287-2324/2).

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Abstract

People's beliefs about the nature of self-control are associated with their self-control performance. However, previous research has not investigated whether lay beliefs depend on *whose* self-control people are thinking about or vary according to personal characteristics affecting self-control, such as ADHD traits. Using questionnaire data from UK participants with (n=91) and without (n=106) ADHD, we found that if people were told that a fictional person had ADHD, they were more likely to assume that this person's self-control was a limited resource and a fixed trait. This effect was even stronger in the ADHD group, regardless of whether they assessed their own and somebody else's self-control. Explorative analyses further suggested that the ADHD group had lower subjective well-being than the comparison group, and this difference was partly mediated by limited self-control beliefs. Self-control beliefs were not consistently associated with people's knowledge and use of situational versus intrapsychic self-control strategies. Maladaptive self-control beliefs may further compromise the self-control performance of people with strong ADHD traits, who are already facing self-control challenges related to executive functioning difficulties.

Keywords: self-control, ADHD, metacognition, lay beliefs, implicit theories, willpower

Self-control allows people to align their behaviour with intention in the face of a motivational conflict (Koi, 2023). These kinds of conflicts are ubiquitous in our lives. To complete a demanding work assignment, we must avoid tempting distractions, and to maintain close relationships, one must be patient in the face of irritations. Accordingly, successful self-control has often been identified as a long-term predictor of favourable outcomes in many areas of life, including academic achievements, good health, and social relationships (Allemand et al., 2019; Daly et al., 2015; Moffit et al., 2011).

How do people think and reason about self-control, both in terms of their own abilities and those of other people? Beliefs about self-control vary between individuals, particularly in terms of whether it is seen as a limited versus nonlimited resource in the short term (Francis & Job, 2018; but see Li et al., 2025). Individuals who view self-control as more limited also show worse self-control performance when faced with high self-regulatory demands – in both laboratory tasks and real-life challenges, such as studying for exams or maintaining a healthy diet (see Francis & Job, 2018). Furthermore, preliminary evidence suggests that self-control beliefs are also associated with subjective well-being and that this relationship is mediated by personal goal progress (Bernecker et al., 2015). Thus, self-control beliefs may shape people's progress toward their personal goals, which in turn affects their subjective well-being – although further research is needed before strong causal claims can be made (see Klinger et al., 2018; Li et al., 2024; Toyama et al., 2022).

Another relevant dimension is whether self-control is seen as fixed versus malleable in the long term, a question that has been studied more with respect to beliefs about other psychological attributes, such as intelligence (see Dweck & Yeager, 2019). Existing research suggests that beliefs about the short-term limitedness and long-term malleability of self-control are relatively independent of each other and differently associated with other

psychological phenomena (Bwalya et al., 2026; Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010). That said, only a few studies have examined multiple self-control belief dimensions simultaneously, and more research is needed to establish the underlying structure of these beliefs (see Li et al., 2025).

However, extant research into self-control beliefs has focused on beliefs about the self, rather than beliefs about the self-control abilities of other people. Most of the research has been conducted either in English, using a scale originally developed by Job et al. (2010), or in German, using a translation of the same scale (see Napolitano & Job, 2018). The original English scale consists of second-person statements describing “your” self-control (e.g., “After a strenuous mental activity, *your* energy is depleted and *you* must rest to get it refuelled again.”; Job et al., 2010). The German translation uses first-person statements (e.g., “After a strenuous mental activity, *my* energy is exhausted and *I* need to recover, to recharge it.”; Napolitano & Job, 2018). Thus, both versions of the scale appear to assess people’s beliefs about their own self-control.

While understanding first-person beliefs about self-control is important, there is also a clear imperative to understand how we reason about the self-control abilities of other people. Previous research on ability beliefs suggests that people may hold different beliefs about the malleability of their own versus other people’s abilities (De Castella & Byrne, 2015; Gunderson et al., 2017). Importantly, our beliefs about other people’s self-control could influence our judgments of their behaviour in everyday situations (see Eme, 2016; Kennett, 2013; Koi, 2021). We might view another person’s inattentiveness or impulsiveness differently depending on how limited or fixed we think their self-control capacity is. Moreover, our beliefs about their self-control might depend on additional information we have about the person. Attention Deficit/Hyperactivity Disorder (ADHD) is a well-known neuropsychiatric diagnosis characterised by attention difficulties, hyperactivity,

and impulsivity. By definition, ADHD traits create additional challenges for self-control: the diagnostic criteria for assessing ADHD include descriptions of characteristics that can be categorised as self-control failures (e.g., difficulties in tasks requiring sustained mental effort or impulsive decision making; see American Psychiatric Association, 2013; World Health Organization, 2019). Indeed, ADHD has even been described as the paradigmatic disorder of self-control (Eme, 2016; but see Koi, 2021). Furthermore, the current discourse emphasizes the neurobiological nature of ADHD (see Dumas-Mallet & Gonon, 2020; Honkasilta & Koutsoklenis, 2022), and empirical studies have observed that a neurobiological framing of psychiatric diagnoses increases beliefs about the fixed nature of the related psychological traits (Leibowitz & Appelbaum, 2019; Röhm et al., 2022). Hence, people's beliefs about the limitedness and malleability of another person's self-control might change if they know that this person has an ADHD diagnosis.

People's beliefs about the limitedness and malleability of self-control may also partly influence the strategies they employ to self-regulate, and conversely, those strategies may influence their self-control beliefs. Although self-control is often understood as an individual struggle, empirical research highlights the situational and interpersonal nature of this phenomenon (see Hofmann, 2024). Some self-control strategies are based on internal psychological mechanisms such as inhibition¹ or cognitive reappraisal of the situation, whereas other strategies rely on the characteristics of one's environment (Duckworth et al., 2016; Hofmann, 2024). In their daily lives, individuals often exercise self-

¹ It should be noted that "inhibition" has been defined and operationalised in varying ways. Indeed, some researchers argue that the dilution and overextension of the construct have undermined research on inhibition and suggest that we should understand inhibition as an outcome rather than a specific mechanism (Werner et al., 2022).

control by selecting and shaping their environments in ways that support their goals. Accordingly, studies have found that people high in trait self-control are better at avoiding temptations and distraction altogether and at setting up their (social) environment such that it supports their goal pursuit (e.g., Ent et al., 2015; vanDellen et al., 2015; but see also Leduc-Cummings et al., 2022). A more multifaceted view of self-control, encompassing the use of situational strategies, could strengthen beliefs that self-control is not a limited resource and that there are things people can do to enhance their self-control. Yet, existing research suggests that in everyday thinking, self-control may still be understood primarily in terms of intrapsychic processes and willpower (Bermudéz et al., 2023; Gennara et al., 2023).

Importantly, the exact usefulness of any strategy will likely depend on the self-control goal in question as well as the characteristics of the individual and their environment (Hennecke & Bürgler, 2020; Bürgler et al., 2021; see also Bonanno & Burton, 2013). For example, people may have to work in environments that they cannot freely modify, or they may face emotional stressors that cannot be solved by proactive action. Hence, while situational strategies can be effective in many contexts, the flexible use of a diverse strategy repertoire might be the most adaptive approach in dealing with self-control challenges.

The distinction between intrapsychic and situational self-control strategies is also relevant in the context of ADHD (Koi, 2021). ADHD is characterized by impairments in executive functioning – the top-down control mechanisms that enable goal-directed behaviour by modulating the operation of various cognitive subprocesses (see Astle et al., 2022; Diamond, 2013; Kofler et al., 2016). It can therefore limit individuals' capacity to use intrapsychic self-control strategies that rely on attentional control and effortful inhibition. Thus, one might expect that situational strategies (e.g., working in distraction-free

environments and relying on social support), which do not similarly depend on effortful executive functioning, would be more effective and less demanding for people with strong ADHD traits. Accordingly, being aware of situational self-control strategies and using them frequently could benefit the well-being of individuals with strong ADHD traits.

This perspective aligns with the broader *neurodiversity* paradigm, which emphasizes that ADHD traits – along with other forms of neurodivergence, such as autistic traits – are a part of the natural variation of human cognition and brain function (e.g., Dwyer, 2022; Ne’eman & Pellicano; Walker, 2021). According to this paradigm, ADHD should not be understood as a disorder of the individual – whether certain traits lead to challenges depends on the immediate environment and broader society (Dwyer, 2022; Walker, 2021; see also Swanepoel et al., 2022). The availability of suitable self-control strategies could be one relevant environmental factor in this equation. To our knowledge, however, little empirical research has been conducted on the self-control strategies people with strong ADHD traits use and how effective they perceive these strategies to be.

The Present Study

In this preregistered questionnaire study, we tested whether people’s beliefs about self-control differ depending on whose self-control they are thinking about, and whether information about an ADHD diagnosis affects these beliefs. We gathered people’s views as to how limited and malleable their own self-control is, and then also asked for their intuitions about these self-control dimensions in fictional people with and without ADHD. We further examined whether beliefs about self-control are associated with respondents’ awareness and use of self-control strategies. Finally, we tested whether people with and without ADHD differ in their ratings of how demanding and effective different self-control strategies are, and whether the use of situational strategies was associated with subjective well-being in people with ADHD.

We had five key predictions. Firstly, we expected that people's beliefs about the limitedness and malleability of self-control would vary depending on whether they are thinking about their own self-control or the self-control of another person. Secondly, we expected people to endorse more limited and fixed beliefs about self-control when thinking about a person with ADHD than when thinking about a neurotypical person. Thirdly, we expected that people's self-control beliefs would be associated with their knowledge and use of self-control strategies, such that less limited and fixed self-control beliefs would be associated with a view of self-control that includes more situational strategies. Fourthly, we expected that, compared to people without ADHD, people with ADHD evaluate intrapsychic self-control strategies to be harder to implement and less effective. Finally, we expected that people with ADHD who report using more situational self-control strategies would have better subjective well-being.

Method

All measures, manipulations, and data/participant exclusions are reported in the manuscript or its supplementary material.

Screening Survey

All recruiting was done via the Prolific recruiting platform (see Peer, 2024), and participants completed the surveys online using Qualtrics. We first conducted a short screening survey (see Materials) to verify that people who had reported in Prolific that they have ADHD scored above the cut-off score in an adult ADHD screening tool (and that people who had reported that they did not have ADHD scored below the same cut-off score). Participants of the initial screening survey were not informed about the existence of another survey in advance. Rather, only those participants who matched the inclusion criteria were later invited to complete the main survey. For both groups, we set 50-50

quotas for men and women to avoid overrepresentation of one gender.² We recruited 331 participants for the screening survey to reach our preregistered sample size of 200 for the main survey. Three participants who completed the main survey were excluded from the analyses because they failed an attention check.

Participants

Our final sample comprised 197 adult UK participants with (n=91) and without (n=106) ADHD or ADD (the formerly used diagnostic term referring to the variant without hyperactivity). The sample size was primarily decided based on monetary resources. As many of our research questions had not been previously explored, it was difficult to conduct valid a priori power calculations. However, our sensitivity analyses suggest that the present sample size had 80% power to detect effects of at least partial $\eta^2=.05$ in the analyses of variance on self-control belief ratings and to detect correlations of at least $|r|=.18$ in the total sample. These sensitivity analyses were conducted with G*Power (Faul et al., 2007).

The ADHD group consisted of people who (1) had reported that they had ADHD *and* (2) scored above the cut-off score in the Adult ADHD Self-Report Scale (ASRS; Schweitzer et al., 2001). Similarly, the non-ADHD group consisted of people who (1) had reported that they did not have ADHD and (2) scored below the cut-off score in the ASRS.

² The binary 50-50 recruiting quota for men and women limits the generalizability of our findings by potentially excluding some non-binary participants. However, our study includes five participants whose gender status in Prolific was either male or female, but who identified as non-binary in our questionnaire. In any case, quantitative research on non-binary people's self-control beliefs would require considerably larger sample sizes or more targeted recruiting.

As people in the UK have varying access to ADHD assessment and may have to spend years on a waiting list (ADHD UK, 2023; Burns et al., 2023), we decided to also include self-diagnosed people in our ADHD group if they scored above the cut-off score in the ASRS. The ASRS score alone does not suffice to confirm an ADHD diagnosis, but our focus was on ADHD as a social category rather than as a clinical diagnosis. This focus was due, in part, to concerns about the cultural specificity and validity of these diagnoses (Astle et al., 2022; Honkasilta & Koutsoklenis, 2022), but also due to the aforementioned practical consideration that waiting times for ADHD assessment can be years long. Thus, in the present study, the goal was simply to gather a group of participants who both identified with the ADHD diagnosis and reported strong ADHD traits – as well as a comparison group that neither identified with the diagnosis nor showed strong ADHD traits.

Sample characteristics are reported in Table 1. Both groups had a broad age range, although the ADHD group was significantly younger than the non-ADHD group; $t(195) = 4.49, p < .001$. There were no significant differences in gender composition, English proficiency, level of education, or annual income (all p -values $> .05$).

The majority of the ADHD group identified as self-diagnosed ($n=58$). Of those who responded to a voluntary follow-up question about medication ($n=70$), 70% had never taken any ADHD-related medication, 17% were currently on medication, and 13% had been on medication more than a year before data collection. All participants in both groups reported being familiar with the term ADHD or ADD – apart from one participant who declined to answer this question. In both groups, the most common source of information was everyday social interactions: friends or family members with the diagnosis and conversations about the topic (see Appendix 2).

Table 1*Sample Characteristics*

	ADHD	Non-ADHD	Group difference
Age	M=34.2 (SD=10.0), Range=19–68	M=42.1 (SD=13.9), Range=18–73	$t(195) = 4.49, p < .001$
ASRS score	M=4.88 (SD=0.93)	M=1.67 (SD=1.13)	$t(195) = -21.58, p < .001$
Gender	51.6% Female, 42.9% Male, 5.5% Non-binary	48,1% Female, 51.9% Male	$\chi^2(1, 195) = 0.57,$ $p=0.45^3$
English proficiency	94.5% Native/bilingual	93.4% Native/bilingual	$\chi^2(2, 195) = 1.78,$ $p=0.41$

Note. $N=197$ (91 in the ADHD group and 106 in the non-ADHD group)

Procedure

In the main survey, participants first filled in scales measuring their beliefs about their own self-control (“you” statements). This part of the survey included the first attention-check item (“There is no actual statement here, this is just a simple attention check. Select all response options.”). Next, participants had to answer questions about their use of different types of self-control strategies and indicate how demanding and effective each strategy was for them. We used both open-ended and multiple-choice questions to examine self-

³ Due to the small number of non-binary participants, gender was treated as a binary variable with non-binary participants excluded from this statistical test.

control strategies. The order of the three scales – self-control beliefs, open-ended strategy questions, and multiple-choice strategy questions – was fixed, but items within the multiple-choice scales were presented in random order.

After this, participants were shown brief descriptions of two fictional persons (with and without ADHD, one at a time) and were then asked to evaluate how limited vs nonlimited and fixed vs malleable the self-control of each fictional person is. The gender (male vs female) and diagnosis (ADHD vs neurotypical) combinations of these fictional persons and their presentation order were counterbalanced between participants. Thus, there are four different versions of this part of the survey (ADHD female, ADHD male, neurotypical female, neurotypical male). Each participant filled in a combination of two scales including a man and woman, and a person with and without ADHD, but the exact pairings varied. This part of the survey included the second attention-check item (identical to the first attention check). The items were presented in random order.

Finally, participants filled in a measure of subjective well-being and answered background questions about their age, gender, proficiency in English, level of education, income, prior knowledge of ADHD, and whether they were taking/had previously taken ADHD medication.

Measures

All measure items of the main survey are reported in Appendix 1.

ADHD Screening

The six-item version of the Adult ADHD Self-Report Scale (ASRS v1.1; Kessler et al., 2005) was used to measure ADHD traits as it is a time-effective questionnaire and highly predictive of ADHD diagnosis (Kessler et al., 2007). The scale comprised of questions describing challenges related to ADHD traits, and participants used a five-point scale (from “Never” to “Very often”) to indicate how often they experience such challenges. The total

score for this scale ranges from 0 to 6, and the cut-off score is 4. Accordingly, a score of 4 or above was an inclusion criterion for the ADHD group in our study.

Self-Control Beliefs

Self-control beliefs were measured with three subscales, each of which included six statements. Participants had to rate these 18 statements on a scale from 1 (“Strongly agree”) to 6 (“Strongly disagree”). Two of the subscales, designed by Job and colleagues (2010), measured how strongly participants endorse a limited view of self-control in the contexts of strenuous mental effort (e.g., “After a strenuous mental activity, your energy is depleted, and you must rest to get it refuelled again.”) and resisting temptations (e.g., “Resisting temptations makes you feel more vulnerable to the next temptations that come along.”), respectively. Additionally, we included a subscale measuring how strongly participants endorse a fixed versus malleable view of self-control (e.g., “Your willpower is something about you that you can’t change very much.”). This subscale was based on the items used to measure implicit theories of intelligence (Dweck, 1999; see Anonymous, in review). The final score for each subscale was derived by calculating the mean of the item scores.

Participants were subsequently introduced to two characters (“Susan” and “David”) and were given some background information about them (see Figure 1). We used very short descriptions only including a drawing of the character, their age (all characters were 30), gender (indirectly based on pronouns), and whether they had any diagnoses (ADHD without any other diagnoses vs neurotypical without any diagnoses). Participants answered adapted versions of the same self-control beliefs questions as before (e.g., “After a strenuous mental activity, Susan feels energized for further challenging activities.”), with responses scored in the same way as before.

Figure 1

Example Description from the Scale Measuring Beliefs About Other People's Self-Control

In this section of the questionnaire, we ask you to respond to the items below thinking about this fictional person.

Susan is 30 years old and has been diagnosed with attention deficit hyperactivity disorder (ADHD). She doesn't have any other diagnoses.

Rate the statements below according to how likely you think they would be true in Susan's case.



Self-Control Strategies

To assess self-control strategies, we first used open-ended questions to ask participants to list three self-control strategies they use in their daily lives. The participants were asked to think about a concrete goal they had and describe three strategies they could use when trying to achieve this goal. The purpose of these questions was to assess what kinds of strategies participants will name spontaneously, without any further guidance. For each strategy, we asked them to evaluate effectiveness ("Is this strategy effective in helping you to pursue your goal?") and demandingness ("Is this strategy hard for you to implement in practice?") on a five-point scale from "Not at all" to "Extremely". Responses to the open-ended questions were coded following the "situational" and "intrapyschic" strategy types suggested by Duckworth et al. (2016). The coding was done by the main author and a research assistant without information about the group membership (ADHD vs non-ADHD) of the participants.

There were three situational strategy classes: social support, situation selection, and situation modification. Situation modification included changes in the concrete physical or digital environment (e.g., closing the office door and turning one's phone off while working), in the task itself or the temporal situation (e.g., taking breaks and rewarding oneself for progress, making a specific schedule or setting a deadline, allocating distraction-free time to work on a specific task), or in one's own body (e.g., using caffeine to keep oneself focused). Intrapsychic strategies included "pure willpower" (i.e., just forcing oneself to concentrate and reach the goal)⁴, cognitive reframing (i.e., focusing on the positive outcome of reaching the goal or the negative outcome of failure), and attentional strategies (i.e., guiding one's attention to something else when facing distractions).

The open-ended questions were followed by a multiple-choice questionnaire (see Appendix 1), which allowed a more controlled assessment of strategy use. Participants were presented with six example strategies (three situational and three intrapsychic; categorised based on the framework suggested by Duckworth et al., 2016). They had to rate how often they used each strategy – on a five-point scale from "(Almost) never" to "(Almost) always". They also evaluated how effective and demanding each strategy was for them in practice, using the same questions and scales as with the self-described strategies. Self-control strategies can also be assessed at a more fine-grained level, yielding a larger number of distinct strategies (e.g., Bürgler et al., 2021). However,

⁴ Similarly to inhibition, it could be argued that this type of "pure willpower" describes an outcome rather than a strategy (see Werner et al., 2022). However, prior research suggests that exerting willpower may nevertheless be a prominent self-control process in people's everyday thinking about the topic (Bermudéz et al., 2023; Gennara et al., 2023). Hence, we wanted to include this strategy category in our study.

considering the overall duration our questionnaire study, we decided to focus on this limited set of higher-level strategy categories derived from the process model of self-control (Duckworth et al., 2016; see also Williamson & Wilkowski, 2020).

Subjective Well-Being

Subjective well-being was measured with the World Health Organisation - Five Well-Being Index (WHO-5; World Health Organization, 1998; see Topp et al., 2015). This scale includes five items measuring current mental well-being. Each item is scored from 1 to 5. The total score, ranging from 0 to 25, is multiplied by 4 to give the final score ranging from 0 to 100.

Demographic Information

In addition, participants were asked to provide information about their age, gender, English proficiency, level of education, annual income, ADHD medication, and knowledge of ADHD (see Appendix 1).

Statistical Analyses

All the analyses were conducted with R (R Core Team, 2025). Statistical analyses were generally carried out following a preregistered analysis plan. However, due to the age difference between the two participants groups, we departed from our original analysis plan to include age as a control variable in our main analyses. Additionally, we also carried out purely explorative analyses, which are explicitly stated as such in the following sections.

We examined the structure of the self-control beliefs scale with correlation tests and Cronbach's alphas. Differences in people's beliefs about self-control in general versus the self-control of a specific fictional person (with and without ADHD) were tested with analyses of variance. We carried out separate ANOVAs for each self-control belief subscale. Furthermore, focusing on beliefs about other people's self-control, we used

multiple linear regression to test the main effects of the diagnosis (ADHD vs neurotypical) and gender (male vs female) of the described fictional person, and the interaction effect of these two on self-control belief scores. We included the gender of the fictional person as a control variable as ADHD has been stereotypically associated with boys/men rather than girls/women (see Horton-Salway, 2013; Martin, 2024), and we thus wanted to check whether people assume that ADHD affects the self-control of men and women differently. Again, separate analyses were conducted for each of the self-control subscales.

The association between self-control beliefs and strategies was examined in two ways. First, we tested whether self-control belief scores correlated with the number of situational strategies that participants listed in the open-ended questions. Second, we tested whether self-control belief scores correlated with the mean frequency of strategy use reported in the multiple-choice questions.

We also conducted multiple regression analyses with the data from the strategy questionnaire to check whether participants with and without ADHD differed in how they rated the effectiveness and demandingness of different types of self-control strategies (situational versus intrapsychic). Finally, within the ADHD group, we tested the correlation between the mean frequency of situational strategy use and subjective well-being as measured by the WHO-5 scale. We used false discovery rate (FDR) correction to adjust p-values when making multiple exploratory statistical tests.

Results

Self-Control Beliefs

Scale Structure

When examining the version of the scale focusing on the original (“you”) version of the scale, all three subscales showed good internal consistency (all Cronbach's alphas $>.80$) in the whole sample, and internal consistency remained at good-to-acceptable levels when

the two participant groups were examined separately (all Cronbach's alphas $>.78$). By contrast, while we only expected a weak-to-moderate correlation between subscales, there was a surprisingly strong positive correlation between the resisting-temptation subscale and the fixedness subscale ($r=.59, p<.001$). This pattern of results remained the same when we examined the two groups separately. Similarly, the version focusing on beliefs about another person's self-control showed good-to-acceptable levels of internal consistency regardless of whether the fictional person had ADHD or not (all Cronbach's alphas $>.77$). However, once again, we observed some above .40 correlations between subscales (see Appendix 3).

Different Beliefs About One's Own Versus Other People's Self-Control

People's limitedness and fixedness beliefs depended on whether they were asked about their own self-control, the self-control of a neurotypical person, or the self-control of a person with ADHD (Table 2).

Importantly, the mean ratings appeared to differ between the two participant groups (ADHD vs non-ADHD; Figure 2). Thus, we extended our ANOVA models to also include the participant group and the interaction between the scale version and the participant group.

The ANOVAs conducted with the mean scores of the three subscales suggested significant differences between the three versions of the scale (Tables 2 and 3). In the case of the two limitedness subscales, the limitedness ratings significantly increased across neurotypical other person, self, and other person with ADHD, all p -values $<.002$. Fixedness beliefs were significantly stronger when participants rated the self-control of other person with ADHD compared to their own self-control ($p<.001$) or the self-control of a neurotypical person ($p<.001$), but the difference between participants' beliefs of their own self-control and neurotypical other person's self-control was not significant ($p=.18$).

Table 2*Self-Control Belief Scales: Means and Standard Deviations*

Subscale	Self		Other Person: Neurotypical		Other Person: ADHD	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Full Sample						
Limited (ME)	4.32	1.01	3.41	1.00	4.64	0.97
Limited (RT)	3.36	0.88	2.90	0.68	4.11	0.84
Fixed	2.74	0.86	2.63	0.75	3.35	0.82
ADHD Group						
Limited (ME)	4.81	0.82	3.07	1.00	4.91	0.96
Limited (RT)	3.82	0.81	2.83	0.70	4.26	0.80
Fixed	3.08	0.86	2.69	0.71	3.48	0.83
Non-ADHD Group						
Limited (ME)	3.90	0.98	3.71	0.91	4.41	0.93
Limited (RT)	2.97	0.74	2.97	0.65	3.98	0.85
Fixed	2.46	0.76	2.58	0.78	3.23	0.80

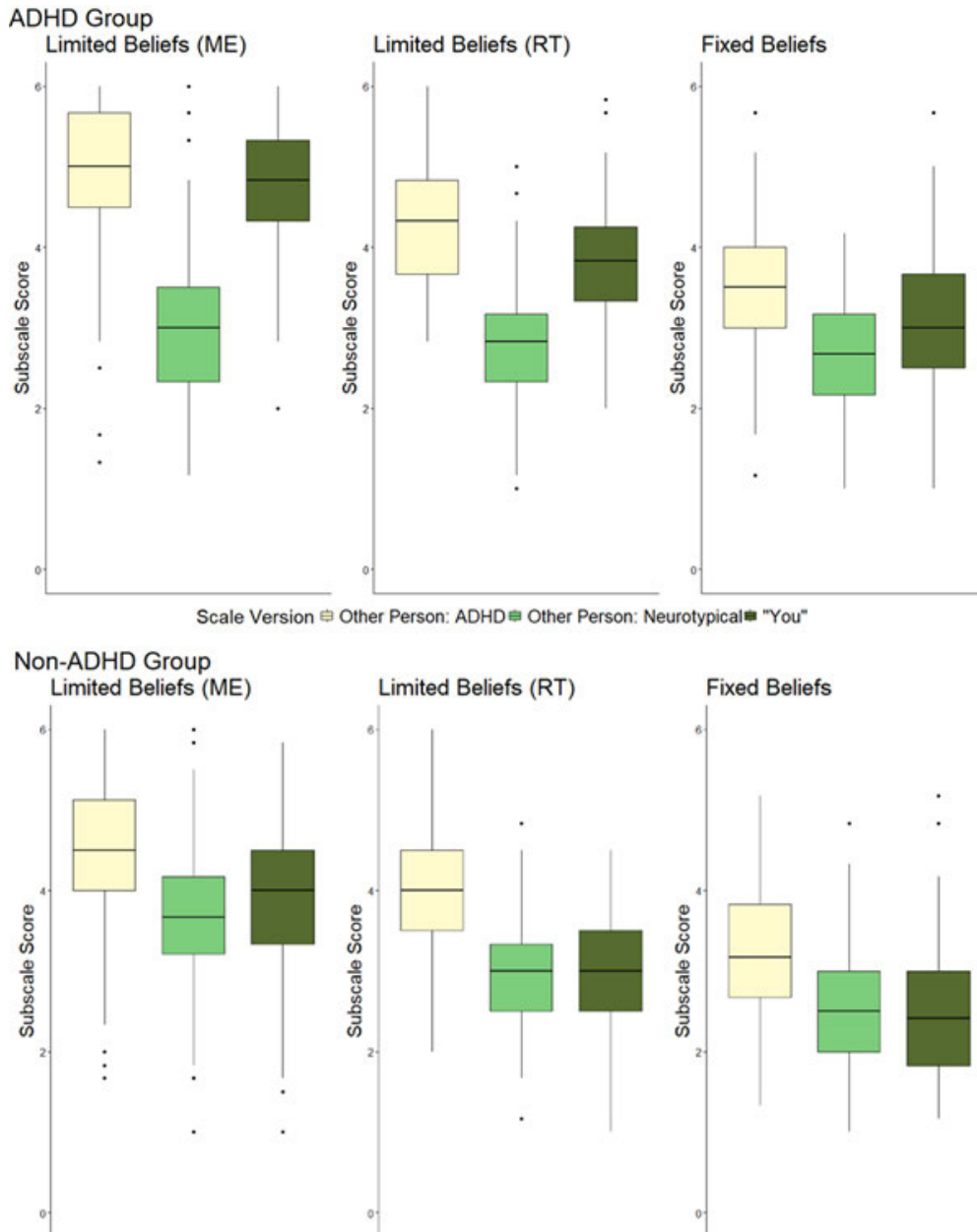
Note. $N=197$ (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort, RT=resisting temptation

The two participant groups differed from each other in all three subscales, such that people in the ADHD group endorsed significantly more limited and fixed beliefs, all p -values $<.002$ (see means in Table 2). Furthermore, there was an interaction between the scale version and the participant group in all three subscales. The non-ADHD group endorsed significantly more limited and fixed beliefs when rating the self-control of other person with ADHD compared to either their own self-control or the self-control of a

neurotypical other person (all p-values <.001), but the difference between the latter two scenarios was not significant (all p-values >.13).

Figure 2

Self-Control Belief Scale Scores



By contrast, in the case of limitedness beliefs related to mental effort, the ADHD group endorsed significantly less limited beliefs when rating the self-control of a neurotypical other person version compared to either their own self-control or the self-

control of other person with ADHD (both p -values $<.001$), but the difference between these two remaining scenarios was not significant, $p=.48$. For limitedness beliefs related to resisting temptation and fixedness beliefs, the ADHD group's limitedness and fixedness ratings significantly increased across neurotypical other person, self, and other person with ADHD, all p -values $<.002$. FDR correction was used in all these post-hoc comparisons.

Due to the significant age difference between the two groups, we also conducted the same analyses with age as a control variable (see Appendix 4). However, there was no effect of age on self-control beliefs, and including age did not affect the overall pattern of results.

Further regression analyses were conducted to specifically test the effect of ADHD diagnosis on participants' ratings of another person's self-control while controlling for the possible effect of gender (Appendix 5). The analyses suggested that, on all three subscales, participants' views about another person's self-control were more limited and fixed when they were thinking about a person with ADHD compared to a neurotypical person. The gender of the fictional person did not affect people's ratings, and there was also no interaction effect between gender and the ADHD status. Again, we conducted the same analyses with age as a control variable. There was no significant effect of age on self-control beliefs in any of these analyses, and the results for other variables did not meaningfully change after age was included in the analyses.

Table 3*Self-Control Belief Scales: Analyses of Variance*

	Sum of Squares	df	Mean Square	<i>F</i>	<i>p</i>	partial η^2
<i>Limited: ME</i>						
Group	9.69	1	9.69	11.08	.001	.02
Scale version	158.85	2	79.42	90.89	<.001	.23
Group*Scale	62.87	2	31.44	35.97	<.001	.11
version						
Residuals	511.23	585	0.87			
<i>Limited: RT</i>						
Group	16.28	1	16.28	28,04	<.001	.05
Scale version	147.14	2	73.57	126.75	<.001	.30
Group*Scale	24.32	2	12.16	20.95	<.001	.07
version						
Residuals	339.56	585	0.58			
<i>Fixed</i>						
Group	15.60	1	15.60	24.89	<.001	.04
Scale version	58.14	2	29.07	46.38	<.001	.14
Group*Scale	6.97	2	3.49	5.56	.004	.02
version						
Residuals	366.66	585	0.63			

Note. *N*=197 (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort,

RT=resisting temptation

Finally, as an explorative analysis, we tested whether ADHD was also associated with beliefs about one's own self-control. The ADHD group endorsed significantly more limited beliefs in relation to both mental effort ($M_{ADHD}=4.81$ vs $M_{N-ADHD}=3.90$, $t[195] = 6.99$, $p<.001$) and resisting temptation ($M_{ADHD}=3.82$ vs $M_{N-ADHD}=2.97$, $t[195] = 7.76$, $p<.001$), as well as significantly more fixed beliefs ($M_{ADHD}=3.08$ vs $M_{N-ADHD}=2.46$, $t[195] = 5.39$, $p<.001$). False discovery rate (FDR) correction was used to adjust the p-values for multiple comparisons. These differences remained significant after controlling for the effect of age (See Appendix 5).

Self-Control Strategies

Open-Ended Strategy Questions

In total, 60% of responses were classifiable under our coding scheme, with half of the remainder not being classifiable as a strategy and the remaining half not falling clearly into any of our groupings. Firstly, many of the responses did not describe anything that could be interpreted as a general strategy (19%). For instance, people gave descriptions of specific work-related tasks or ambiguous one-word responses. Secondly, some strategies were difficult to categorise in terms of the "situational" versus "intrapsychic" scheme (21%). For example, some reported that they break the task into smaller intermediate steps without mentioning anything about scheduling or deadlines. Of the remaining data, 285 responses (48%) were classified as situational strategies, and 72 responses (12%) as intrapsychic strategies. The frequencies of each strategy type are shown in Table 5.

Coded Strategy Responses and Self-Control Beliefs

Contrary to our hypothesis, there was a significant *positive* correlation between limitedness beliefs and the number of situational strategies described in the open-ended questions. Describing more situational strategies was associated with stronger limitedness beliefs in the context of both mental effort ($r=.17$, $p=.014$) and resisting temptation ($r=.18$, $p=.013$).

There was a trend towards the same direction for fixedness beliefs, but the correlation was not significant ($r=.14$, $p=.051$). However, this finding is complicated by a potential confounding variable: the ADHD group and the non-ADHD group differed both in their self-control beliefs and the number of situational strategies they named. Indeed, when we conducted regression analyses and included the participant group as a control variable, the number of situational strategies was not significantly associated with any of the self-control beliefs subscales (all p -values $>.11$; see Appendix 5).

Table 5

Coded Responses to the Open-Ended Strategy Questions

Strategy type	ADHD	Non-ADHD	Full sample
Situational: Social support	25 (9%)	19 (6%)	44 (7%)
Situational: Situation selection	19 (7%)	18 (6%)	37 (6%)
Situational: Situation modification	106 (39%)	98 (31%)	204 (34%)
Intrapsychic: "Pure willpower"	22 (8%)	30 (9%)	52 (9%)
Intrapsychic: Cognitive reframing	9 (3%)	6 (2%)	15 (3%)
Intrapsychic: Attentional	0	5 (2%)	5 (1%)
Other strategies	60 (22%)	61 (19%)	121 (20%)
Other responses	32 (12%)	82 (26%)	114 (19%)
Total	273	319	592

Note. N=197 (91 in the ADHD group and 106 in the non-ADHD group)

Multiple-Choice Strategy Questions: Self-Reported Use

People's responses to multiple-choice questions suggested that the most frequently used strategies were situation selection, "pure willpower", and situation modification (Table 6; see Appendix 7 for correlations between strategies). Overall, the ADHD and non-ADHD groups gave similar responses. However, the non-ADHD group used "pure willpower" significantly more frequently than the ADHD group. There was no significant difference

between the two groups in the use of any other strategy after correcting for multiple comparisons.

Table 6

Self-Reported Strategy Use: Mean Frequencies

Strategy type	ADHD		Non-ADHD		<i>t</i> (195)	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Situational: Social support	2.95	1.21	2.72	1.08	-1.40	.243
Situational: Situation selection	3.65	1.10	3.49	1.02	-1.05	.356
Situational: Situation modification	3.11	1.05	3.25	1.06	0.90	.370
Intrapsychic: "Pure willpower"	3.04	0.93	3.56	0.90	3.94	<.001
Intrapsychic: Cognitive reframing	2.98	1.00	2.73	0.99	-1.77	.201
Intrapsychic: Attentional	2.88	0.95	3.11	1.03	-1.65	.201

Note. *N*=197 (91 in the ADHD group and 106 in the non-ADHD group): false discovery rate (FDR) correction was used to adjust the *p*-values for multiple comparisons

Self-Reported Strategy Use and Self-Control Beliefs

We calculated the mean frequency of situational strategy use for each participant based on their responses to the three multiple-choice questions describing situational strategies. Contrary to our hypothesis, there was no association between these frequency ratings and limitedness beliefs. There was no significant correlation between self-reported use of situational strategies and limitedness beliefs in the context of mental effort ($r=.07$, $p=.364$) or resisting temptation ($r=.02$, $p=.744$). By contrast, more frequent use of situational strategies was weakly associated with a *more fixed* view of self-control ($r=.23$, $p=.001$). However, this association was no longer significant after controlling for the overall effect of participant group ($p=.067$).

Self-Reported Effectiveness and Demandingness

The mean effectiveness ratings were relatively similar for all strategies and both participant groups (see Appendix 8). However, compared to the non-ADHD group, the ADHD group rated social support ($M_{ADHD}=2.88$ vs $M_{N-ADHD}=3.39$, $t[195] = 3.42$, $p=.005$) and situation selection as less effective ($M_{ADHD}=2.90$ vs $M_{N-ADHD}=3.31$, $t[195] = 2.51$, $p=.039$). There was a consistent difference between the two subsamples in how demanding the strategies were rated to be. The ADHD group rated every strategy as more difficult to implement in practice than the non-ADHD group (all p -values $<.05$; see Appendix 8).

Table 7

Regression Analyses: Self-Reported Effectiveness and Demandingness

	Estimate	SE	95% CI		<i>p</i>
			LL	UL	
<i>Effectiveness</i>					
Intercept	3.248	0.066	3.118	3.378	<.001
Group (ADHD)	-0.120	0.097	-0.311	0.071	.218
Strategy type (Situational)	0.104	0.094	-0.080	0.288	.268
Group*strategy type	-0.283	0.138	-0.554	-0.013	.040
Adjusted R^2	.01				
<i>Demandingness</i>					
Intercept	2.497	0.068	2.364	2.629	<.001
Group (ADHD)	0.620	0.099	0.425	0.815	<.001
Strategy type (Situational)	-0.028	0.096	-0.216	0.159	.767
Group*strategy type	0.047	0.141	-0.229	0.322	.740
Adjusted R^2	.06				

Note. $N=197$, *CI* = confidence interval; *LL* = lower limit; *UL* = upper limit

We aggregated participants' ratings of effectiveness and demandingness by strategy type (situational versus intrapsychic) to test whether the mean ratings for effectiveness and demandingness of the different types of strategies differed between the ADHD and non-ADHD groups (see Table 7). In terms of self-perceived effectiveness, we observed an interaction effect between participant group and strategy type (standardised coefficient -0.10). The direction of this interaction was unexpected. People in the ADHD group evaluated intrapsychic strategies ($M=3.13$) as slightly *more effective* than situational strategies ($M=2.95$), whereas people in the non-ADHD group evaluated situational strategies ($M=3.35$) as slightly more effective than intrapsychic strategies ($M=3.25$). This effect remained significant after controlling for age (see Appendix 9). With regard to self-perceived demandingness, the regression analysis only suggested a main effect of the participant group such that people in the ADHD group rated strategies as more demanding regardless of the strategy type (standardised coefficient 0.25). However, the proportion of variance explained was very small for both regression models (Table 7).

Subjective Well-Being

Finally, there was no association between the mean frequency of situational strategy use and subjective well-being as measured by the WHO-5 scale in either the ADHD group ($r=.01$, $p=.96$) or the non-ADHD group ($r=.10$, $p=.32$). Furthermore, regression analysis did not find main effects of participant group or situational strategy use or interaction between them (all p-values $>.30$).

However, our explorative analyses suggested that the ADHD group reported significantly poorer well-being than the non-ADHD group ($M_{ADHD}=40.22$ vs $M_{N-ADHD}=56.98$, $t[195] = 5.99$, $p<.001$). Moreover, limited beliefs about self-control were negatively associated with subjective well-being in both groups (see Appendix 10). We further conducted exploratory mediation analyses to test whether the well-being difference

between the two groups was partially mediated by differences in self-control beliefs. This post-hoc analysis suggested that limitedness beliefs in the context of both mental effort and resisting temptation independently mediated the effect of ADHD on subjective well-being (Appendix 10). That is, we observed an indirect effect of ADHD group on WHO-5 score through both mental-effort limitedness beliefs ($b=-4.79$, $SE=1.46$, 95% CI [-7.68, -1.92]) and resisting-temptation limitedness beliefs ($b=-4.51$, $SE=1.76$, 95% CI [-8.23, -1.25]). The reported confidence intervals are based on 10 000 bootstrap samples. The R package “lavaan” (Rosseel, 2012) was used in this multiple-mediator analysis.

Discussion

In this study, we examined how people’s beliefs about self-control are shaped by contextual information. As expected, people’s self-control beliefs differed depending on whose self-control they were thinking about, and judgments about other people’s self-control were affected by ADHD diagnosis. If people were told that a fictional person had an ADHD diagnosis, they assumed that this person’s self-control was more limited and fixed. People associated ADHD with more limited and fixed self-control regardless of whether they themselves had an ADHD diagnosis. However, for limitedness beliefs, the effect was stronger in the ADHD group than in the non-ADHD group. By contrast, the gender of the described person did not affect self-control beliefs.

These findings are in line with existing theory and empirical research. The core traits associated with ADHD – attention difficulties, hyperactivity, impulsivity – are easy to interpret as limitations of self-control or willpower (see Eme, 2016; Koi, 2021). Moreover, the current discourse underlines the neurobiological underpinnings of ADHD (see Dumas-Mallet & Gonon, 2020; Honkasilta & Koutsoklenis, 2022). Research on ADHD and other psychiatric diagnoses suggests that a neurobiological framing can increase beliefs about the fixed nature of the related psychological traits (Lebowitz et al., 2016; Röhm et al.,

2022; see also Leibowitz & Appelbaum, 2019). Thus, publicly available information about ADHD may guide people to rate another person's self-control as more limited and fixed if they are told this person has ADHD. Although both participant groups were familiar with ADHD, the ADHD group had first-hand experience of ADHD traits and had been somewhat more exposed to ADHD-related information from other sources (Appendix 2). This may explain why the ADHD group associated the diagnosis more strongly with limited self-control capacity. That said, the present data does not allow us to distinguish whether people's responses primarily reflected a) common stereotypes and cultural narratives about ADHD, b) knowledge from more established sources (e.g., the diagnostic criteria), and/or c) their own personal experiences with other people. While such dissection might be difficult in the case of a well-known and common diagnosis, qualitative studies could offer insights into how these different sources of information shape people's beliefs about self-control in ADHD. Future research could examine whether the observed effect of ADHD diagnosis on beliefs about another person's self-control also affects the type of advice people give to a person facing a self-control challenge and whether self-control beliefs are associated with judgments about responsibility (see Koi, 2021).

Furthermore, compared to the non-ADHD group, the ADHD group also endorsed more limited and fixed beliefs about their own self-control when filling in the original version of the scale. In this sense, people's beliefs about their own self-control seemed to align with their beliefs about the self-control of another person with the same ADHD status. Indeed, the ADHD-related differences in limitedness and fixedness ratings were clearer and more consistent than the self-versus-other differences. The ADHD group saw both their own self-control and the self-control of another person with ADHD as more limited and fixed than the self-control of a neurotypical person. However, their beliefs about their own self-control did not significantly differ from their beliefs about the self-control of

another person with ADHD. Further research is needed to confirm that the original version of the scale measures participants' beliefs about their own self-control rather than general baseline beliefs (i.e., second-person passive; see De Castella & Byrne, 2015). However, the assumption that the original scale assesses people's beliefs about their own self-control is indirectly supported by the fact that the ADHD group's responses to the original scale were closer to their responses regarding another person with ADHD than their responses regarding a neurotypical person, whereas the non-ADHD group showed an opposite pattern.

Previous studies using the same limitedness subscales have found that a limited view of self-control can lead to poorer self-control performance (see Francis & Job, 2018). Thus, such beliefs could create additional challenges for people with strong ADHD traits. Indeed, we found indirect support for this in our explorative analyses. Firstly, the ADHD group reported significantly poorer subjective well-being than the non-ADHD group – in line with earlier research (e.g., French et al., 2024; Fuller-Thompson et al., 2022). Secondly, this difference was partly explained by differences in limitedness beliefs. However, it must be emphasized that our explorative mediation analysis with correlational data does not allow strong causal claims. More research is needed to test whether these associations can be replicated and to examine the underlying mechanisms. That said, earlier correlational studies have suggested that limitedness beliefs are associated with poorer well-being during periods of high self-control demands (Bernecker & Job, 2017). This earlier work found that the association was partly mediated by goal striving, such that more limited beliefs were associated with less successful goal striving, which in turn predicted worse well-being.

Importantly, viewing self-control as limited may not always be harmful (see Toyama et al., 2022; Vohs et al., 2012). In some cases, a limited view may even be adaptive: if a

person knows that they will face several tasks requiring effortful self-control, understanding self-control as a limited resource can keep them from exhausting themselves during the first task and allow them to complete the latter tasks more successfully (Toyama et al., 2022). Arguably, since attentional control is more difficult to people with strong ADHD traits, viewing one's self-control as a limited resource might be both realistic and adaptive for them in contexts where no situational strategies are available. Moreover, believing that self-control is a fixed trait might become harmful mainly at the instance of a self-control failure – as has been previously suggested by research on ability beliefs (see Dweck & Yeager, 2019). Thus, systematically assessing and/or experimentally inducing experiences of self-control failure might be necessary for uncovering the potential relationships between fixedness beliefs, goal striving, and subjective well-being.

There was no consistent association between self-control beliefs and people's knowledge or use of situational versus intrapsychic strategies. When strategies were assessed with open-ended questions, we found that describing more situational strategies was associated with *stronger* limitedness beliefs. However, this finding appeared to be driven by the overall difference between the ADHD and non-ADHD groups in both strategy responses and limitedness beliefs. When the participant group was controlled for, there was no significant association between the number of situational strategies participants described and their self-control beliefs. Similarly, when analysing the multiple-choice questionnaire data, we found a weak correlation between more frequent use of situational strategies and a more fixed view of self-control, but this association disappeared when we controlled for the effect of participant group.

We expected that having situational strategies in one's self-control repertoire could encourage a less limited and more malleable view of self-control. However, even if people know and use situational strategies, they might not count these as examples of self-control

or willpower – at least not to the same extent as intrapsychic strategies. Previous studies have reported this type of lay distinction between prototypical, intrapsychic self-control and more situational strategies (Bermudéz et al., 2023; Gennara et al., 2023). This distinction might therefore explain the lack of consistent association between self-control beliefs and strategies – especially considering that the self-control belief scale used in our study and previous literature refers explicitly to “willpower”. Moreover, the fact that people systematically associated ADHD – a condition affecting executive functioning – with more limited and fixed self-control is also in line with the interpretation that self-control, as measured by these scales, was understood in intrapsychic terms. These findings suggest a possible mismatch between lay understandings of self-control and many current theoretical models of self-control proposed based on empirical research (e.g., Duckworth et al., 2016; Hofmann, 2024; Milyavskaya et al., 2019; but see Sripada., 2021). Yet it should also be noted that our study had limited statistical power to detect weak correlations ($>.18$). Thus, larger scale studies should be conducted to further assess the possible associations between strategies and self-control beliefs.

Another surprise was that the ADHD group rated situational strategies *less effective* than intrapsychic strategies. Only the non-ADHD group rated situational strategies as more effective. Moreover, although the ADHD group consistently rated all strategies as more demanding than the non-ADHD group, the self-perceived demandingness did not vary between situational and intrapsychic strategies. There was also no association between situational strategy use and subjective well-being. Thus, our findings do not support the hypothesis that intrapsychic strategies would be less beneficial for people with ADHD due to challenges in executive functioning (see Koi, 2021). However, the present questionnaire data does not allow us to assess whether and how participants actually used each strategy in their daily lives – or how successful they were when implementing each

strategy. By relying on participants' ability to accurately evaluate their behaviour, self-rate measures may conflate actual self-control performance with metacognitive capabilities. Furthermore, it should be noted that evidence about the adaptiveness of situational strategies has been mixed in previous studies (see Bürgler et al., 2021; Hofmann, 2024). A more nuanced approach might be needed in research on self-control strategies, with a focus on how people's strategy choices match with context-specific demands. While strong ADHD traits might make intrapsychic strategies less accessible in general, these strategies may still be the most effective option available in contexts where the successful use of situational strategies is difficult for other reasons (e.g., relatively inflexible working environments).

Strengths and Limitations

To our knowledge, this study is the first one to examine whether people's beliefs about self-control may vary depending on whose self-control they are thinking about. Moreover, our preregistered study design included two participant groups, allowing us to examine the effects of ADHD in terms of both (1) how knowledge about another person's ADHD diagnosis affects beliefs about their self-control and (2) how self-control beliefs differ between people with and without ADHD.

One of the main limitations of our study is that it did not include a task-based measure of self-control. Thus, as stated above, we cannot draw conclusions about people's objective self-control performance. Additionally, 40% of the responses to the open-ended strategy questions did not fit in our coding scheme. The high response exclusion rate may have created additional noise in the analyses with open-ended strategy data. That said, we also assessed people's everyday self-control strategies with multiple-choice questions, which provided systematic data on people's use of different strategies as well as the perceived effectiveness and demandingness of these strategies. Future studies

can further illuminate the possible association between self-control beliefs and strategies by combining self-report measures with task-based measures of self-control performance.

Another limitation concerns the recruiting method of our study. When recruiting our participant groups, we purposefully only included people who either reported having ADHD and scored above the cut-off score on the ADHD screening measure (the ADHD group) or reported not having ADHD and scored below the cut-off score on the screening measure (the non-ADHD group). As the associations between ADHD and self-control beliefs had not been studied previously, we considered that this “extreme groups” design would be a suitable approach for the first study on this topic. In real life, however, ADHD is not a binary variable – rather, ADHD traits form a continuum. Moreover, people may have relatively strong ADHD traits without identifying with the diagnosis and vice versa. More research is thus needed to differentiate between the effects of ADHD traits and ADHD diagnosis on self-control beliefs.

Thirdly, when using the original version of the self-control beliefs scale, we found surprisingly strong positive correlations between limitedness beliefs in the context of resisting temptation and fixedness beliefs. Based on previous findings (Anonymous, in review; see also Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010), we expected only weak-to-moderate correlations between limitedness and fixedness beliefs. Moreover, we found preliminary evidence that the structure of self-control beliefs might vary depending on whose self-control people are thinking about (Appendix 3). Thus, the structure of self-control beliefs should be further examined in future research, but this issue does not disqualify the main findings of the present study. Although the associations between different types of self-control beliefs are more complicated than previous studies suggest, we can still conclude that ADHD was consistently associated with more limited and fixed beliefs across different subscales.

More generally, as noted above, the small sample size of our study limited our ability to reliably detect small effects. This should be considered both when interpreting the lack of consistent associations between self-control strategies and other measured variables and when examining some of the smaller effects reported regarding self-control beliefs. Studies with larger sample sizes should thus be conducted to further test the present pattern of results.

Finally, our analyses on people's beliefs about other people's self-control focused on a within-participant comparison between a person with ADHD and a neurotypical person. Although the presentation order was counterbalanced, this design may have created a forced-choice situation, directing participants to make their judgments based on the ADHD diagnosis alone. In real life, one can usually gather more information about the people with whom they interact and is not required to make explicit judgments based on minimal information (i.e., age, gender, and diagnoses). Moreover, it is possible that we would also observe similar effects with other diagnoses or characteristics that could affect self-control (e.g., depression, addiction, age-related comparisons). Future studies could use a more comprehensive design to systematically test how different types of information affect lay beliefs about other people's self-control. However, it should be noted that we did not find any effect of gender on these beliefs. This at least suggests that self-control beliefs are not equally affected by just any personal characteristic.

Conclusion

People express different views about the short-term limitedness and long-term malleability of self-control depending on the characteristics of the person they are thinking about. One such characteristic is an ADHD diagnosis: if people know that a person has ADHD, they are more likely to assume that this person's self-control is a limited resource and a fixed trait. The effect of ADHD diagnosis on limitedness beliefs is even stronger in

people who themselves have ADHD. Furthermore, explorative analyses suggested that the ADHD group had lower subjective well-being than the comparison group, and this difference was partly explained by the ADHD group's more limited self-control beliefs. In addition to challenges related directly to attentional control, people with ADHD may also face additional disadvantages caused by self-reinforcing beliefs about the limitedness and fixedness of their self-control. Future research should further examine the mechanisms underlying the observed associations and test whether the differences in self-control beliefs affect people's overall sense of agency, their judgments of responsibility, and the advice they give to other people who are facing self-control challenges. Eventually, this work can help us to tailor individualised ways to support people's self-control without reinforcing maladaptive beliefs.

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Appendix 1: Questionnaires

The Adult ADHD Self-Report Scale

First, we would like to ask you about some possible challenges you may face in your daily activities. Please answer the questions below, rating yourself on each of the criteria shown. As you answer each question, select the box that best describes how you have felt and conducted yourself over the past 6 months

1. How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?

Never

Rarely

Sometimes

Often

Very Often

2. How often do you have difficulty getting things in order when you have to do a task that requires organisation?

3. How often do you have problems remembering appointments or obligations?

4. When you have a task that requires a lot of thought, how often do you avoid or delay getting started?

5. How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?

6. How often do you feel overly active and compelled to do things, like you were driven by a motor?

Self-Control Beliefs (“You”)

This questionnaire has been designed to investigate your ideas about willpower. Willpower is what you use to resist temptations, to stick to your intentions, and to remain in strenuous mental activity. There are no right or wrong answers. We are interested in your ideas.

Using the scale below, please indicate how much you agree or disagree with each of the following statements.

Strongly agree
Moderately agree
Slightly agree
Slightly disagree
Moderately disagree
Strongly disagree

[Limitedness (Mental Effort) 1] When you have been working on a strenuous mental task, you feel energized and you are able to immediately start with another demanding activity.

[Limitedness (ME) 2] Your mental stamina fuels itself. Even after strenuous mental exertion, you can continue doing more of it.

[Limitedness (ME) 3] After a strenuous mental activity, you feel energized for further challenging activities.

[Limitedness (ME) 4] Strenuous mental activity exhausts your resources, which you need to refuel afterwards (e.g., through taking breaks, doing nothing, watching television, eating snacks).

[Limitedness (ME) 5] After a strenuous mental activity, your energy is depleted, and you must rest to get it refuelled again.

[Limitedness (ME) 6] When you have completed a strenuous mental activity, you cannot start another activity immediately with the same concentration because you have to recover your mental energy again.

[Limitedness (Resisting Temptation) 1] If you have just resisted a strong temptation, you feel strengthened and you can withstand any new temptations.

[Limitedness (RT) 2] Resisting temptations activates your willpower and you become even better able to face new upcoming temptations.

[Limitedness (RT) 3] Your capacity to resist temptations is not limited. Even after you have resisted a strong temptation you can control yourself right afterwards.

[Limitedness (RT) 4] Resisting temptations makes you feel more vulnerable to the next temptations that come along.

[Limitedness (RT) 5] When situations accumulate that challenge you with temptations, it gets more and more difficult to resist the temptations.

[Limitedness (RT) 6] It is particularly difficult to resist a temptation after resisting another temptation right before.

[Fixedness 1] There are things you can do to improve your willpower.

[Fixedness 2] Some things you do can damage your willpower in the long term.

[Fixedness 3] Your willpower is something about you that you can learn to change.

[Fixedness 4] You have a certain amount of willpower and you can't really do much to change it.

[Fixedness 5] Your willpower is something about you that you can't change very much.

[Fixedness 6] You can learn new things, but you can't really change your willpower.

[Attention Check] There is no actual statement here, this is just a simple attention check.

Select all response options.

Self-Control Beliefs (Other Person: ADHD)

In this section of the questionnaire, we ask you to respond to the items below thinking about this fictional person. Susan is 30 years old and has been diagnosed with attention deficit hyperactivity disorder (ADHD). She doesn't have any other diagnoses. Rate the statements below according to how likely you think they would be true in Susan's case.



[Limitedness (Mental Effort) 1] When Susan has been working on a strenuous mental task, she feels energized and is able to immediately start with another demanding activity.

Strongly agree

Moderately agree

Slightly agree

Slightly disagree

Moderately disagree

Strongly disagree

[Limitedness (ME) 2] Susan's mental stamina fuels itself. Even after strenuous mental exertion, she can continue doing more of it.

[Limitedness (ME) 3] After a strenuous mental activity, Susan feels energized for further challenging activities.

[Limitedness (ME) 4] Strenuous mental activity exhausts Susan's resources, which she needs to refuel afterwards (e.g., through taking breaks, doing nothing, watching television, eating snacks).

[Limitedness (ME) 5] After a strenuous mental activity, Susan's energy is depleted, and she must rest to get it refuelled again.

[Limitedness (ME) 6] When Susan has completed a strenuous mental activity, she cannot start another activity immediately with the same concentration because she has to recover her mental energy again.

[Limitedness (Resisting Temptation) 1] If Susan has just resisted a strong temptation, she feels strengthened and she can withstand any new temptations.

[Limitedness (RT) 2] Resisting temptations activates Susan's willpower and she becomes even better able to face new upcoming temptations.

[Limitedness (RT) 3] Susan's capacity to resist temptations is not limited. Even after she has resisted a strong temptation she can control herself right afterwards.

[Limitedness (RT) 4] Resisting temptations makes Susan feel more vulnerable to the next temptations that come along.

[Limitedness (RT) 5] When situations accumulate that challenge Susan with temptations, it gets more and more difficult for her to resist the temptations.

[Limitedness (RT) 6] It is particularly difficult for Susan to resist a temptation after resisting another temptation right before.

[Fixedness 1] There are things Susan can do to improve her willpower.

[Fixedness 2] Some things Susan does can damage her willpower in the long term.

[Fixedness 3] Susan's willpower is something about her that she can learn to change.

[Fixedness 4] Susan has a certain amount of willpower and she can't really do much to change it.

[Fixedness 5] Susan's willpower is something about her that she can't change very much.

[Fixedness 6] Susan can learn new things, but she can't really change her willpower.

Self-Control Beliefs (Other Person: Neurotypical)

In this section of the questionnaire, we ask you to respond to the items below thinking about this fictional person. David is 30 years old. He doesn't have any medical diagnoses. David is neurotypical (not autistic, diagnosed with ADHD, dyslexia, anxiety, or any other condition that would be considered neurodivergent). Rate the statements below according to how likely you think they would be true in David's case.



[Limitedness (Mental Effort) 1] When David has been working on a strenuous mental task, he feels energized and is able to immediately start with another demanding activity.

Strongly agree

Moderately agree

Slightly agree

Slightly disagree

Moderately disagree

Strongly disagree

[Limitedness (ME) 2] David's mental stamina fuels itself. Even after strenuous mental exertion, he can continue doing more of it.

[Limitedness (ME) 3] After a strenuous mental activity, David feels energized for further challenging activities.

[Limitedness (ME) 4] Strenuous mental activity exhausts David's resources, which he needs to refuel afterwards (e.g., through taking breaks, doing nothing, watching television, eating snacks).

[Limitedness (ME) 5] After a strenuous mental activity, David's energy is depleted, and he must rest to get it refuelled again.

[Limitedness (ME) 6] When David has completed a strenuous mental activity, he cannot start another activity immediately with the same concentration because he has to recover his mental energy again.

[Limitedness (Resisting Temptation) 1] If David has just resisted a strong temptation, he feels strengthened and he can withstand any new temptations.

[Limitedness (RT) 2] Resisting temptations activates David's willpower and he becomes even better able to face new upcoming temptations.

[Limitedness (RT) 3] David's capacity to resist temptations is not limited. Even after he has resisted a strong temptation he can control herself right afterwards.

[Limitedness (RT) 4] Resisting temptations makes David feel more vulnerable to the next temptations that come along.

[Limitedness (RT) 5] When situations accumulate that challenge David with temptations, it gets more and more difficult for him to resist the temptations.

[Limitedness (RT) 6] It is particularly difficult for David to resist a temptation after resisting another temptation right before.

[Fixedness 1] There are things David can do to improve his willpower.

[Fixedness 2] Some things David does can damage his willpower in the long term.

[Fixedness 3] David's willpower is something about him that he can learn to change.

[Fixedness 4] David has a certain amount of willpower and he can't really do much to change it.

[Fixedness 5] David's willpower is something about him that he can't change very much.

[Fixedness 6] David can learn new things, but he can't really change his willpower.

Self-Control Strategies (Open-Ended)

For the next set of questions, you must think about some goal you have in your work or studies (e.g., completing an especially difficult or boring task at work, studying hard for an exam). You should choose a concrete goal that requires you to focus on a single task for an extended period of time, ignoring any distractions and resisting competing temptations.

Write the goal you chose below.

In which ways have you tried to keep on successfully pursuing your goal?

Below you can describe the things you typically do to reach your goals. Try to come up with three different strategies. You should also rate how effective each strategy has been **to you personally** and how hard it is **for you** to implement it.

1. Strategy

Is this strategy effective in helping you to pursue your goal?

Not at all	Just a little	Somewhat	Quite a bit	Extremely
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Is this strategy hard for you to implement in practice?

Not at all	Just a little	Somewhat	Quite a bit	Extremely
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2. Strategy

Is this strategy effective in helping you to pursue your goal?

Is this strategy hard for you to implement in practice?

3. Strategy

Is this strategy effective in helping you to pursue your goal?

Is this strategy hard for you to implement in practice?

Self-Control Strategies (Multiple-Choice)

The following statements refer to behaviours people may engage in when pursuing their goals. Please rate how often you do these things yourself. After each statement, you should also evaluate how effective each strategy has been to you personally and how hard it is for you to implement it.

1. I avoid some situations because they have distractions that would interfere with my goal (e.g., avoiding rooms with a lot of noise or other distractions).

(Almost) never

Rarely

Sometimes

Often

(Almost) always

Is this strategy effective in helping you to pursue your goal?

Not at all

Just a little

Somewhat

Quite a bit

Extremely

Is this strategy hard for you to implement in practice?

Not at all

Just a little

Somewhat

Quite a bit

Extremely

2. When I am tempted to do something that would interfere with my goal, I try to guide my attention on something else (e.g., music, media, conversation with a friend, or another engaging activity).
3. When I am tempted to do something that would interfere with my goal, I use willpower to force myself to stay on task.
4. I change my situation to get rid of things that could interfere with my goal (e.g., turning off your phone and placing it far away from you).
5. When I am tempted to do something that would have interfered with my goal, I change the way I think about the situation (e.g., by focusing on the negative consequences of getting distracted from my goal, by trying to find positive aspects from the task I need to complete to reach my goal).
6. I rely on social support from others (e.g., by working together with my colleagues/coursemates, by making myself accountable to someone about my progress).

The WHO-5 Well-Being Index

The next questions are about your current mental wellbeing.

Over the past two weeks...

1. I have felt cheerful and in good spirits.

All of the time

Most of the time

More than half of the time

Less than half of the time

Some of the time

At no time

2. I have felt calm and relaxed.
3. I have felt active and vigorous.
4. I woke up feeling fresh and rested.
5. My daily life has been filled with things that interest me.

Background Information

Next, we will ask you to provide some background information about yourself.

Age in years

Gender

Male

Female

Other

Prefer not to say

English proficiency

Beginner

Intermediate

Advanced

Native/bilingual

What is the highest level of education you have completed?

Primary

Secondary

Further

Higher: Bachelor's Degree

Higher: Master's Degree

Higher: PhD

Which of the following best describes your personal income last year (before taxes)?

Below £15 000

£15 000–25 000

£26 000–40 000

£40 000–60 000

Over £60 000

Have you been diagnosed with attention deficit hyperactivity disorder (ADHD) or attention deficit disorder (ADD)?

Diagnosed ADHD/ADD

Self-diagnosed ADHD/ADD

Neither

Prefer not to say

If you have been diagnosed with ADHD/ADD, are you taking any medication related to this diagnosis?

Yes, I'm currently on medication

Not right now, but I've been on medication within the last year

Not recently, but I've been on medication more than a year ago

No, I've never taken any ADHD/ADD-related medication

Not applicable

Prefer not to say

How familiar you are with ADHD/ADD? Select all options that apply to you.

I have ADHD or ADD myself

At least one of my friends or family members has ADHD/ADD

The topic has been covered in my studies

I often encounter ADHD/ADD in my work

I have read/watched/listened ADHD/ADD-related content from traditional media outlets

I have read/watched/listened ADHD/ADD-related content from social media

ADHD/ADD has come up in conversations

I have never heard about neither ADHD or ADD

Prefer not to say

Appendix 2: Additional Background Information

Table A1

Knowledge of ADHD: Sources of Information

	ADHD	Non-ADHD
At least one friend or family member has ADHD/ADD	65.9%	51.4%
The topic has been covered in their studies	23.1%	18.1%
Often encounter ADHD/ADD in their work	24.2%	21.9%
Traditional media outlets	41.8%	35.2%
Social media	41.8%	32.3%
ADHD/ADD has come up in conversations	64.8%	61.9%

Note. N=197 (91 in the ADHD group and 106 in the non-ADHD group)

Appendix 3: Self-Control Beliefs: Scale Structure

Table A2

Self-Control Belief Scales: Internal Consistency Measured by Cronbach's α

Subscale	Self	Other Person: Neurotypical	Other Person: ADHD
	α	α	α
Full Sample			
Limited (ME)	.90	.92	.91
Limited (RT)	.85	.78	.85
Fixed	.82	.82	.82
ADHD Group			
Limited (ME)	.86	.91	.92
Limited (RT)	.81	.79	.83
Fixed	.84	.77	.82
Non-ADHD Group			
Limited (ME)	.89	.92	.90
Limited (RT)	.79	.78	.85
Fixed	.79	.85	.81

Note. N=197 (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort,

RT=resisting temptation

Table A3*Correlations Between Subscales: The Original Version of the Scale ("You")*

Subscale	Limitedness (ME)	Limitedness (RT)	Fixedness
Limitedness (ME)	1	.42 ($p<.001$)	-.04 ($p=.560$)
Limitedness (RT)		1	.59 ($p<.001$)
Fixedness			1

Note. N=197 (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort, RT=resisting temptation

Table A4*Correlations Between Subscales: Neurotypical Other Person*

Subscale	Limitedness (ME)	Limitedness (RT)	Fixedness
Limitedness (ME)	1	.64 ($p<.001$)	-.29 ($p<.001$)
Limitedness (RT)		1	.51 ($p<.001$)
Fixedness			1

Note. N=197 (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort, RT=resisting temptation

Table A5*Correlations Between Subscales: Other Person with ADHD*

Subscale	Limitedness (ME)	Limitedness (RT)	Fixedness
Limitedness (ME)	1	.43 ($p<.001$)	-.06 ($p=.387$)
Limitedness (RT)		1	.45 ($p<.001$)
Fixedness			1

Note. N=197 (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort, RT=resisting temptation

Appendix 4: Self-Control Beliefs: ANOVAs with Age as a Control Variable

Table A6

Self-Control Belief Scales: Analyses of Variance

	Sum of Squares	df	Mean Square	<i>F</i>	<i>p</i>	partial η^2
<i>Limited: ME</i>						
Age	1.34	1	1.34	1.53	.216	<.001
Group	8.39	1	8.39	9.59	.001	.02
Scale version	158.85	2	79.42	90.74	<.001	.24
Group*Scale version	62.87	2	31.44	35.91	<.001	.11
Residuals	511.18	584	0.88			
<i>Limited: RT</i>						
Age	0.00	1	0.00	0.00	.991	.005
Group	17.94	1	17.94	31.00	<.001	.05
Scale version	147.14	2	73.57	127.15	<.001	.30
Group*Scale version	24.32	2	12.16	21.01	<.001	.07
Residuals	337.90	584	0.58			
<i>Fixed</i>						
Age	0.37	1	0.37	0.59	.442	.01
Group	18.87	1	18.87	30.35	<.001	.05
Scale version	58.14	2	29.07	46.76	<.001	.14
Group*Scale version	6.97	2	3.49	5.61	.004	.02
Residuals	363.02	584	0.62			

Note. *N*=197 (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort,

RT=resisting temptation

Appendix 5: Self-Control Beliefs: Regression Analyses

Table A7

Regression: Beliefs About Other Person's Self-Control

	Estimate	SE	95% CI		p
			LL	UL	
<i>Limited: ME</i>					
Intercept	3.767	0.128	3.515	4.019	<.001
Group (ADHD)	-0.775	0.191	-1.150	-.0399	<.001
Other's ADHD	0.534	0.185	0.171	0.897	<.004
Other's gender (Male)	-0.120	0.185	-0.285	0.269	.516
Group*Other's ADHD	1.354	0.272	0.821	1.888	<.001
Group*Other's gender	0.276	0.272	-0.258	0.810	.310
Other's ADHD*Other's gender	0.326	0.261	-0.188	0.839	.213
Group*ADHD*Gender	-0.428	0.384	-1.183	0.327	.266
Adjusted R^2	.33				
<i>Limited: RT</i>					
Intercept	2.988	0.152	2.787	3.188	<.001
Group (ADHD)	-0.224	0.147	-0.524	0.075	.141
Other's ADHD	0.894	0.147	0.610	1.184	<.001
Other's gender (Male)	-0.046	0.216	-0.335	0.243	.754
Group*Other's ADHD	0.505	0.216	0.080	0.931	.020
Group*Other's gender	0.174	0.208	-0.251	0.599	.422
Other's ADHD*Other's gender	0.240	0.306	-0.170	0.649	.250
Group*ADHD*Gender	-0.163	0.152	-0.765	0.438	.594
Adjusted R^2	.40				

Fixed

Intercept	2.700	0.106	2.492	2.908	<.001
Group (ADHD)	-0.224	0.158	-0.350	0.270	.798
Other's ADHD	0.538	0.153	0.239	0.838	<.001
Other's gender (Male)	-0.242	0.153	-0.541	0.058	.114
Group*Other's ADHD	0.259	0.224	-0.182	0.700	.248
Group*Other's gender	0.301	0.224	-0.140	0.742	.181
Other's ADHD*Other's gender	0.228	0.216	-0.196	0.652	.290
Group*ADHD*Gender	-0.241	0.317	-0.864	0.383	.449
Adjusted R^2	.17				

Note. N=197, CI = confidence interval; LL = lower limit; UL = upper limit, ME=mental effort,

RT=resisting temptation

Table A8*Regression: Beliefs About Other Person's Self-Control with Age as a Control Variable*

	Estimate	SE	95% CI		p
			LL	UL	
<i>Limited: ME</i>					
Intercept	3.692	0.208	3.283	4.101	<.001
Age	0.002	0.004	-0.006	0.010	.646
Group (ADHD)	-0.757	0.195	-1.140	-.0374	<.001
Other's ADHD	0.531	0.185	0.168	0.895	<.004
Other's gender (Male)	-0.122	0.185	-0.486	0.241	.508
Group*Other's ADHD	1.348	0.272	0.813	1.883	<.001
Group*Other's gender	0.270	0.272	-0.265	0.805	.322
Other's ADHD*Other's gender	0.330	0.262	-0.184	0.845	.207
Group*ADHD*Gender	-0.416	0.385	-1.173	0.342	.281
Adjusted R ²	.33				
<i>Limited: RT</i>					
Intercept	2.782	0.165	2.457	3.107	<.001
Age	0.005	0.003	-0.001	0.011	.114
Group (ADHD)	-0.176	0.155	-0.481	0.128	.255
Other's ADHD	0.888	0.147	0.599	1.176	<.001
Other's gender (Male)	-0.053	0.147	-0.342	0.236	.720
Group*Other's ADHD	0.488	0.216	0.063	0.913	.025
Group*Other's gender	0.157	0.216	-0.268	0.582	.468
Other's ADHD*Other's gender	0.253	0.208	-0.156	0.662	.224
Group*ADHD*Gender	-0.129	0.306	-0.731	0.473	.673
Adjusted R ²	.40				

Fixed

Intercept	2.457	0.171	2.120	2.793	<.001
Age	0.006	0.003	-0.001	0.012	.072
Group (ADHD)	0.016	0.160	-0.299	0.331	.919
Other's ADHD	0.530	0.152	0.231	0.830	.001
Other's gender (Male)	-0.250	0.152	-0.549	0.050	.102
Group*Other's ADHD	0.239	0.224	-0.201	0.680	.286
Group*Other's gender	0.281	0.224	-0.160	0.721	.211
Other's ADHD*Other's gender	0.244	0.215	-0.179	0.667	.257
Group*ADHD*Gender	-0.201	0.317	-0.824	0.423	.527
Adjusted R^2	.18				

Note. N=197, CI = confidence interval; LL = lower limit; UL = upper limit, ME=mental effort,

RT=resisting temptation

Appendix 6: Coded Strategy Responses and Self-Control Beliefs

Table A9

Regression Analyses: Self-Control Belief Subscale Scores

	Estimate	SE	95% CI		p
			LL	UL	
<i>Limited: ME</i>					
Intercept	3.779	0.118	3.547	4.010	<.001
ADHD group	0.874	0.131	0.615	1.133	<.001
Situational strategy count	0.095	0.061	-0.024	0.215	.118
Adjusted R^2	.20				
<i>Limited: RT</i>					
Intercept	2.863	0.100	2.666	3.060	<.001
ADHD group	0.826	0.111	0.606	1.046	<.001
Situational strategy count	0.080	0.052	-0.022	0.182	.122
Adjusted R^2	.24				
<i>Fixed</i>					
Intercept	2.373	0.105	2.166	2.580	<.001
ADHD group	0.599	0.117	0.368	0.830	<.001
Situational strategy count	0.065	0.054	-0.042	0.171	.235
Adjusted R^2	.13				

Note. N=197, CI = confidence interval; LL = lower limit; UL = upper limit, ME=mental effort, RT=resisting temptation; false discovery rate correction was used to adjust the p-values for multiple comparisons

Appendix 7: Correlations Between Strategies in the Multiple-Choice Data

There were only two significant correlations between the frequency ratings of different strategies after correcting for multiple comparisons. Within situational strategies, more frequent use of situation selection was moderately associated with more frequent use of situation modification ($r=.39, p<.001$). Similarly, within intrapsychic strategies, the use of “pure willpower” was moderately associated with the use of attentional strategies ($r=.33, p<.001$). None of the other correlations was significant after correcting for multiple comparisons (all p -values $>.10$).

Table A10

Self-Reported Strategy Use: Correlations Between Strategies

Strategy type	1	2	3	4	5	6
1 Social support	1	.08	-.08	-.10	.08	.14
2 Situation selection		1	.39***	.07	.02	.05
3 Situation modification			1	.14	.08	.14
4 "Pure willpower"				1	0	.33***
5 Cognitive reframing					1	-.02
6 Attentional						1

*Note. N=197; *** $p < .001$; false discovery rate correction was used to adjust the p -values for multiple comparisons*

Appendix 8: Self-Reported Effectiveness and Demandingness of the Strategies

Table A11

Self-Reported Effectiveness of the Strategies

Strategy type	ADHD		Non-ADHD		<i>t</i> (195)	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Situational: Social support	2.88	1.09	3.39	0.99	3.42	.005
Situational: Situation selection	2.90	1.23	3.31	1.06	2.51	.039
Situational: Situation modification	3.07	1.19	3.36	1.22	-1.70	.137
Intrapsychic: "Pure willpower"	3.20	1.28	3.17	1.23	-0.16	.893
Intrapsychic: Cognitive reframing	3.16	1.27	3.19	1.22	0.13	.893
Intrapsychic: Attentional	3.02	1.20	3.39	1.20	2.13	.070

Note. *N*=197 (91 in the ADHD group and 106 in the non-ADHD group): false discovery rate correction was used to adjust the *p*-values for multiple comparisons

Table A12

Self-Reported Demandingness of the Strategies

Strategy type	ADHD		Non-ADHD		<i>t</i> (195)	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Situational: Social support	3.01	1.18	2.48	1.13	-3.21	.002
Situational: Situation selection	3.22	1.17	2.46	1.11	-4.66	<.001
Situational: Situation modification	3.18	1.23	2.46	1.19	-4.14	<.001
Intrapsychic: "Pure willpower"	3.25	1.23	2.54	1.32	-3.91	<.001
Intrapsychic: Cognitive reframing	2.93	1.30	2.52	1.23	-2.30	.022
Intrapsychic: Attentional	3.16	1.28	2.43	1.11	-4.29	<.001

Note. *N*=197 (91 in the ADHD group and 106 in the non-ADHD group): false discovery rate correction was used to adjust the *p*-values for multiple comparisons

Appendix 9: Self-Control Strategy Analyses with Age as a Control Variable

Table A13

Regression Analyses: Self-Reported Effectiveness and Demandingness

	Estimate	SE	95% CI		p
			LL	UL	
<i>Effectiveness</i>					
Intercept	2.980	0.135	2.714	3.245	<.001
Age	0.006	0.003	0.001	0.012	.023
Group (ADHD)	-0.070	0.100	-0.266	0.126	.484
Strategy type (Situational)	0.104	0.094	-0.080	0.287	.267
Group*strategy type	-0.283	0.138	-0.553	-0.013	.040
Adjusted R^2	.02				
<i>Demandingness</i>					
Intercept	2.619	0.068	2.364	2.629	<.001
Age	-0.003	0.003	-0.009	0.003	.313
Group (ADHD)	0.598	0.102	0.398	0.797	<.001
Strategy type (Situational)	-0.028	0.096	-0.216	0.159	.767
Group*strategy type	0.047	0.141	-0.229	0.322	.740
Adjusted R^2	.06				

Note. $N=197$, CI = confidence interval; LL = lower limit; UL = upper limit

Appendix 10: Subjective Well-Being and Self-Control Beliefs

Table A14

Group Differences in Subjective Well-Being and Self-Control Beliefs

	ADHD	Non-ADHD	Group difference
WHO-5	M=40.22 (SD=20.23)	M=56.98 (SD=19.00)	$t(195) = 5.99, p < .001$
Limited (ME)	M=4.81 (SD=0.82)	M=3.90 (SD=0.98)	$t(195) = 6.99, p < .001$
Limited (RT)	M=3.82 (SD=0.81)	M=2.97 (SD=0.74)	$t(195) = 7.76, p < .001$
Fixed	M=3.08 (SD=0.86)	M=2.46 (SD=0.76)	$t(195) = 5.39, p < .001$

Note. $N=197$ (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort, RT=resisting temptation

Mediation Analysis

Initial correlation analyses suggested that both types of limitedness beliefs in the domain of mental effort were negatively correlated with well-being in both ADHD ($r = -.29, p = .008$) and non-ADHD groups ($r = .34, p = .001$). Similarly, resisting-temptation were negatively associated with well-being in both ADHD ($r = -.29, p = .008$) and non-ADHD groups ($r = -.30, p = .003$). There was no significant negative correlation between fixedness beliefs and well-being in either ADHD ($r = -.14, p = .19$) or non-ADHD group ($r = -.07, p = .48$).

We then conducted a multiple-mediator analysis to examine whether the mental-effort and resisting-temptation limitedness beliefs mediated the effect of ADHD group on subjective well-being. Our analysis suggests a significant total effect of ADHD group on WHO-5 score (Table A15; standardised estimate -0.18). We also observed indirect effect of ADHD group on mental-effort limitedness beliefs (standardised estimate 0.45) and an indirect effect of mental-effort limitedness beliefs on WHO-5 score (standardised estimate -

0.25). Similarly, there was an indirect effect of ADHD group on resisting-temptation limitedness beliefs (standardised estimate 0.49) and an indirect effect of resisting-temptation limitedness beliefs on WHO-5 score (standardised estimate -0.22).

Furthermore, when we tested model parameters by taking 10 000 bootstrap samples, both the indirect effect through mental-effort limitedness beliefs (standardised estimate -0.133) and the indirect effect through resisting-temptation limitedness beliefs (standardised estimate -0.106) remained significant.

Table A15*Multiple-Mediator Analysis: Subjective Well-Being*

	Estimate	SE	95% CI		<i>p</i>
			<i>LL</i>	<i>UL</i>	
<i>Regressions</i>					
WHO-5 ~					
Limitedness (ME)	-5.274	1.549	-8.196	-2.114	.001
Limitedness (RT)	-5.274	1.903	-9.038	-1.568	.006
ADHD Group	-7.459	3.208	-13.821	-1.146	.020
Limitedness (ME) ~					
ADHD Group	0.909	0.127	0.655	1.157	<.001
Limitedness (RT) ~					
ADHD Group	0.855	0.109	0.642	1.073	<.001
<i>Covariance</i>					
Limitedness (ME) ~~					
Limitedness (RT)	0.244	0.061	0.126	0.367	<.001
<i>Variances</i>					
WHO-5	326.736	28.123	265.767	375.112	<.001
Limitedness (ME)	0.818	0.090	0.642	0.995	<.001
Limitedness (RT)	0.589	0.058	0.472	0.700	<.001
<i>Defined Parameters</i>					
Indirect 1	-4.792	1.457	-7.682	-1.919	.001
Indirect 2	-4.510	1.764	-8.226	-1.250	.011
Total	-16.761	2.831	-22.307	-11.172	<.001

Note. N=197 (91 in the ADHD group and 106 in the non-ADHD group); ME=mental effort,

RT=resisting temptation, CI=confidence interval (based on 10 000 bootstrap samples);

LL=lower limit; UL=upper limit.

In this Chapter, I have reported the results of our study with UK participants with and without ADHD. Previous research suggests that people's beliefs about self-control predict their self-control performance and real-life outcomes. The present experimental findings demonstrate that people express different views about the short-term limitedness and long-term malleability of self-control depending on the characteristics of the person they are thinking about. If people know that a person has ADHD, they are more likely to assume that this person's self-control is a limited resource and a fixed trait. Moreover, this effect was stronger in people with ADHD, regardless of whether they assessed their own and somebody else's self-control. The observed effects may further hamper the self-control of people with strong ADHD traits. In addition to challenges related directly to attentional control, they may also face additional disadvantages caused by self-reinforcing beliefs about the limits of their self-control.

The fact that people systematically associated ADHD – a condition affecting executive functioning – with more limited and fixed self-control may further suggest that intrapsychic strategies have a prominent role in lay beliefs about self-control. The next chapter will focus on executive function and a specific type of intrapsychic strategy - that is, the use of inner speech.

Chapter 4 The Role of Inner Speech in Working Memory Maintenance and Updating

In the present chapter, I will focus on strategy use in an executive function task. Two online studies examined the role of inner speech in working memory performance in adult UK participants. The aim was to test whether verbal representations may provide a general processing advantage that supports not only the maintenance of task-relevant information but also its updating. Furthermore, I also tested whether self-control beliefs predicted working memory performance of verbal strategy use.

This chapter has been written up for publication as *The Role of Inner Speech in Working Memory Maintenance and Updating* by Anssi Bwalya, Hugh Rabagliati, and Nicolas Chevalier.

Abstract

Inner speech, which refers to self-directed speech without audible articulation, aids working memory (WM) by offering verbal memory cues for the short-term maintenance of task-relevant information. The present studies examined whether (a) inner speech also supports information updating, and (b) inner speech use depends on metacognition and self-control beliefs. Two online studies combined a visual running memory task with articulatory suppression to study the role of inner speech in WM maintenance and updating. Both studies also included metacognition and self-control beliefs questionnaires. Disrupting inner speech affected WM maintenance in Study 1 (n=49) and updating in Study 2 (n=49), albeit in different ways, suggesting that inner speech may support both information maintenance and updating. Almost all participants reported being aware of using self-directed speech in the task and finding it helpful, extending prior findings with younger populations to adults. No relations were observed between self-control beliefs and inner speech use or overall WM performance.

Keywords: working memory, inner speech, executive function, language, metacognition, lay beliefs, self-control

Our inner experiences often have a verbal dimension. *Inner speech* refers to the subjective experience of language without audible articulation (Alderson-Day & Fernyhough, 2015). Much of the psychological research on inner speech has focused on its cognitive functions. A century ago, Lev Vygotsky argued that inner speech was the outcome of a developmental process in which language is first used in social exchanges and gradually becomes an internalized tool for self-regulation (see Alderson-Day & Fernyhough, 2015; Vasileva & Balyasnikova, 2019). Subsequent research has found evidence for the increasing role of verbal strategies in cognitive control over the course of childhood (Alderson-Day & Fernyhough, 2015; Cragg & Nation, 2010).

More recently, studies have examined the role of inner speech in working memory (WM) – where information relevant to ongoing activities is maintained in a readily accessible form. This line of research has clear practical implications, as WM capacity predicts academic achievement (Ahmed et al., 2019; Peng et al., 2018; Spiegel et al., 2021) and has also been associated with other important real-life outcomes, such as job performance and health (Mashburn et al., 2023). Typically, studies have used a dual-task design to test whether people use inner speech to support their WM performance (e.g., Baddeley et al., 2001; Emerson & Miyake, 2003; Saeki et al., 2013). Participants perform a WM task while simultaneously engaging in either a verbal or non-verbal secondary task. The verbal secondary task condition, called *articulatory suppression*, requires the participants to repeat a simple word or syllable while doing the task, hence preventing inner speech from being used for the primary task. The non-verbal control task is something equally simple, such as foot tapping, which does not affect inner speech. While the overall processing costs of both secondary tasks are similar, performance is worse under articulatory suppression, suggesting that participants use inner speech to support their WM performance (see Alderson-Day & Fernyhough, 2015). Moreover, developmental

studies have found that children gradually begin to use inner speech for this purpose between 6 and 9 years of age (Fatzer & Roebers, 2012; Hitch & Halliday, 1983).

Although the exact nature of WM is a debated issue (Adams et al., 2018), the most influential theories agree that WM encompasses the short-term maintenance and manipulation or updating of information (Baddeley, 2012; Cowan, 2017). Inner speech in the form of articulatory rehearsal is in itself a WM maintenance strategy (Camos et al., 2009). Accordingly, empirical studies suggest that inner speech supports the short-term maintenance of information in the form of articulatory rehearsal (Alderson-Day & Fernyhough, 2015; Baddeley, 2012). However, verbal representations may provide a more general processing advantage that is not limited to articulatory rehearsal (e.g., Kompa & Mueller, 2020; Lupyan & Swingley, 2012). For example, the linguistic code of inner speech may be an efficient tool not only for retrieving and maintaining task-relevant representations but also for updating and manipulating them (Kompa & Mueller, 2020). Language provides us with abstract, sparse representations (e.g., “human”, “chair”) that reduce cognitive load and increase computational power (by contrast, visual representations cannot freely omit detail). Thus, in addition to information maintenance, inner speech may support information updating in WM.

Some empirical studies have directly examined the possible role of inner speech in WM updating using a running memory task (Morris & Jones, 1990; Yue et al., 2008; see also Doiseau & Isingrini, 2005). In this task, lists of individual letters were presented one letter at a time. Participants had to continuously keep in mind the four most recent letters. At the end of each trial, they were asked to report these four letters. The length of the list varied from trial to trial and the shortest lists only included four letters. By varying the number of letters in a given trial, the experimenters aimed to also vary the number of WM updates. In both studies, articulatory suppression had a negative effect on response

accuracy. Similarly, increases in the number of letters presented (the number of updates) tended to lead to decreases in accuracy. However, there was no interaction between these two – that is, the effect of articulatory suppression was not greater when more updates were required, suggesting that its effect on task performance was not related to updating processes. The authors concluded that since the effect of articulatory suppression did not increase cumulatively with increased WM updating demands, inner speech does not play a role in updating and is only used for WM maintenance.

However, these earlier studies had some methodological caveats. Firstly, they had very small sample sizes ($n=12-14$) and thus limited statistical power to detect the potential effect of articulatory suppression on WM updating. Furthermore, other researchers have questioned whether participants actually update their WM throughout the running memory task used in these studies (Palladino & Jarrold, 2008; see also Botto et al., 2014). Participants may instead passively wait for the list to end and then try to recall the most recent items. Thus, more studies with tasks designed to disentangle WM subprocesses are needed to better understand how inner speech supports WM.

Insofar as people implement inner speech intentionally, it is also important to consider how *metacognitive* factors may influence inner speech use to support information maintenance and/or updating. Metacognition refers to one's knowledge and control of their own cognitive functioning (Flavell, 1979). Inner speech can be studied as an object of metacognition: people may vary in their knowledge about inner speech, their conscious use of verbal memory strategies, and their evaluation of the usefulness of such strategies. There is relatively little research on people's metacognitive awareness of inner speech, and this work has focused on children and adolescents. Metacognitive awareness of inner speech increases gradually during childhood (e.g., Flavell et al., 1997). Similarly, in a study with a cross-sectional sample of children and adolescents, awareness of one's use of

inner speech in cognitive tasks increased with age (Winsler & Naglieri, 2003). However, this increase was not linear: awareness peaked at 14–15 years and was lower in the oldest adolescents. Interestingly, greater awareness of verbal strategy use was associated with better task performance, whereas verbal strategy use per se was not (apart from the youngest children). Finally, awareness of private speech was positively associated with age, greater expressive language skills, greater use of private speech, and better performance in a mentalizing task in preschool children (Manfra & Winsler, 2006). To our knowledge, similar research has not been conducted with adults.

Considering the repetitive and cognitively demanding nature of the tasks used in the inner speech literature, research on *self-control* might also be relevant for understanding the results of these studies. Self-control refers to actions that we take to align our behaviour with a motivational commitment, such as an intention or better judgment, in the face of conflicting impulses or motives (Koi, 2021). Focusing on a tedious WM task could be considered a self-control challenge. Indeed, executive functioning tasks have been widely used in self-control research (Enkavi et al., 2019; Friedman & Banich, 2019; Pilcher et al., 2023). Importantly, there are meaningful differences in people's metacognition about self-control, including their beliefs about the nature of self-control (Hennecke & Bürgler, 2023). Many studies have examined people's beliefs about self-control as a limited versus nonlimited resource – that is, whether people think that exercising self-control leads to a temporary lack of self-control afterwards (Francis & Job, 2018). When people are faced with high self-control demands, a more nonlimited view of self-control appears to be associated with better self-control performance in both laboratory tasks and real-life situations (Francis & Job, 2018; but see also Toyama et al., 2022). Furthermore, manipulating people's self-control beliefs can affect their performance in subsequent, extended self-control tasks, suggesting causal effects (Haimovitz et al., 2020; Job et al.,

2010; Miller et al., 2012). Beliefs may affect self-control performance by guiding how people interpret their mental fatigue (Francis & Job, 2018; Job et al., 2010; see also Clarkson et al., 2016) or how likely they are to persist in a task, trying various self-control strategies (Haimovitz et al., 2020).

Both hypothetical mechanisms could also affect people's performance in an extended, strenuous WM task. When participants must continue a mentally effortful task for multiple trial sequences, a limited view of self-control might lead them to interpret any fatigue as a sign that they have exhausted their self-control resources. This, in turn, could decrease their motivation to aim towards high accuracy in the task or try out new memory strategies, leading to worse overall task performance. Moreover, if a nonlimited view of self-control generally encourages the use of different strategies, it could also increase people's use of verbal strategies in the form of inner speech. However, to our knowledge, this hypothesis has never been empirically tested.

Overview of the Studies

In the present online studies, we examined the role of inner speech in WM maintenance and updating. We used a visual WM task that allowed us to independently manipulate maintenance and updating demands. We ran two studies, as the results of Study 1 suggested that our original manipulation of updating demands was not effective enough. In Study 2, we modified the WM task such that the main effect of updating demands would be stronger, allowing us a better chance to detect the hypothesized association between WM updating and inner speech. Similarly to earlier inner speech studies, we relied on a dual-task design and compared participants' performance during articulatory suppression versus a non-verbal secondary task. Furthermore, we planned to examine whether participants' self-reported use and self-perceived usefulness of self-directed speech were associated with a greater effect of articulatory suppression and whether perceived task

difficulty was positively associated with the use of self-directed speech. Finally, we tested whether nonlimited beliefs about self-control are associated with better WM task performance and the use of self-directed speech.

We had six hypotheses and predictions. (1) Based on the earlier research, we expected that WM performance would be worse in the articulatory-suppression condition compared to the foot-tapping condition. (2) We further expected that articulatory suppression would affect both WM maintenance and WM updating such that there would be an interaction effect between articulatory suppression and both maintenance and updating, respectively. (3) With regard to task perceptions and metacognitive awareness, we expected adults to use inner speech consciously and the effect of articulatory suppression to thus be stronger in participants who report using self-directed speech in the non-verbal control condition. (4) Similarly, we expected the self-perceived usefulness of self-directed speech to positively correlate with the observed effect of articulatory suppression. Finally, regarding self-control beliefs, we expected people with more nonlimited view of self-control to be more inclined to stay focused on the task and use verbal memory strategies and therefore (5) nonlimited theories about self-control would be positively associated with WM performance and (6) the use of inner speech

Data Availability

The materials, data, and analysis code of the present studies are available in the Open Science Framework at <https://doi.org/10.17605/OSF.IO/RWZ9U>

Study 1

Method

Participants

The final sample included 44 adults (33 female, 11 male) living in the United Kingdom. Participants were recruited through two channels: 1) a volunteer panel of the local

university, comprising mostly elderly adults, and 2) the student volunteer panel of the same university. The former group received a gift card for their participation, whereas the latter group was rewarded with course credits. All participants were native English speakers. The age range of our sample was 18–74 years ($M=32.2$, $SD=17.4$).

Due to the lack of prior research providing rigid effect size estimates, a target sample size of 50 participants was primarily decided based on resource constraints. The exclusion rate for this study was unexpectedly high. To reach our final sample size, we had to recruit 106 participants in total. Thus, 62 participants were excluded from the final sample. The exclusion rate was 64% with the student volunteer panel and 52% with the non-student volunteer panel. Most common reasons for exclusion were not following the secondary task instructions ($n=30$), not meeting the inclusion criteria in terms of language proficiency ($n=18$), providing valid responses in less than 90% of the WM display sequences ($n=16$), and/or technical problems in the audio recording ($n=6$).

Due to the lack of prior research providing effect size estimates for the effect of articulatory suppression on specific WM subprocesses, the target sample size was primarily decided based on monetary resources and time constraints. That said, the sample of Study 1 is more than three times larger than in any single study in the prior work on WM updating and inner speech (Morris & Jones, 1990; Yue et al., 2008). Moreover, earlier research (Emerson & Miyake, 2003; Saeki et al., 2013) on the general effect of articulatory suppression on executive functioning in adults reports large effects (eta squared estimates between 0.2 and 0.5), suggesting that our sample size should be sufficient for detecting the main effect of articulatory suppression.

Procedure

The online study was conducted using the Gorilla Experiment Builder. The study included a visual WM task, a questionnaire assessing participants' perceptions of the WM task and

their use of self-directed speech, and a questionnaire measuring their implicit theories about willpower/self-control. The total duration of the experiment was approximately 50 minutes.

WM task

The WM task was adapted from the tasks used by Kessler and colleagues (Kessler & Meiran, 2008; Kessler & Oberauer, 2014). In the task, participants had to maintain and update pictures in their WM. We used 12 pictures chosen from the set of stimuli commissioned by Rossion and Pourtois (2004) which is based on an earlier database by Snodgrass and Vanderwart (1980). They depicted animals, plants, everyday objects and simple symbols (e.g., dog, tree, chair, heart).

Each trial started with two or four pictures, presented within squares (Figure 1). The subsequent displays could contain either new images or repetitions. If there was a new picture within a square, participants had to forget the previous picture and now maintain the new picture in their WM instead. If there was an asterisk within a square, participants had to remember the previous picture shown in that square, which made it harder to rely on a simple recall strategy at the end of the trial and encouraged participants to maintain the relevant items in their WM throughout the task. The task was self-paced: the participants decided when they wanted to move to the next display. At the end of the display sequence, participants were presented with question marks and had to name out loud the most recent item in each square from left to right. There was a 30-second break every fifth trial. The audio was recorded throughout the task, excluding the breaks.

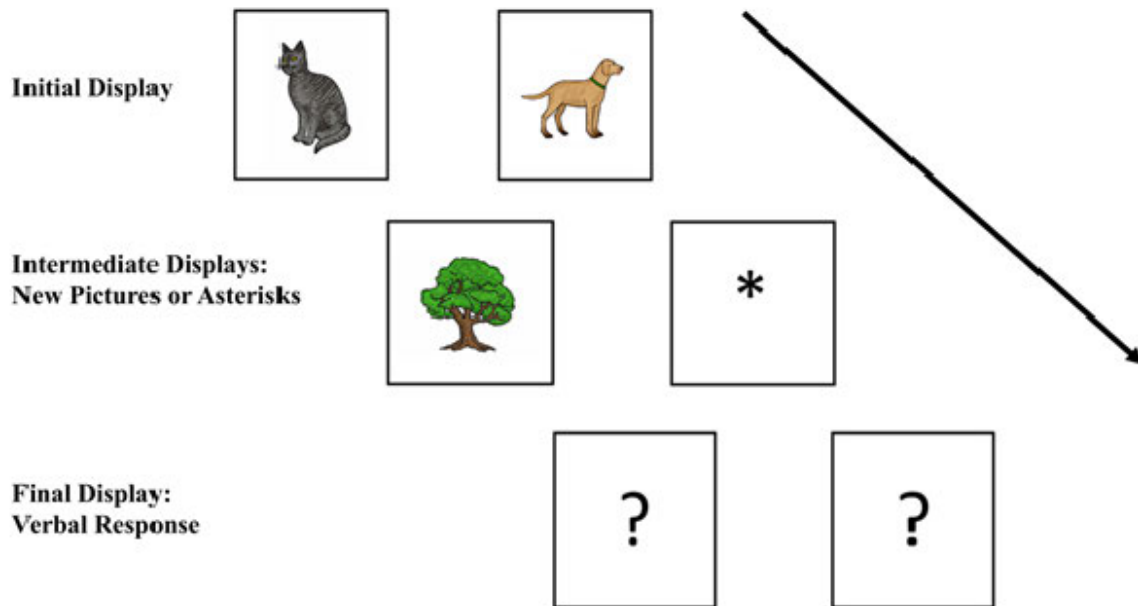
The length of display sequences varied randomly between 4 and 8 sequences such that all possible sequence lengths (i.e., 4, 5, 6, 7, and 8) were featured an equal number of times. The variation in sequence length meant that the participants could not anticipate when they would be asked to recall the most recent items. There were 20 trials per













secondary task condition (see below), yielding a total number of 40 sequences per participant (Figure 1).

To study the role of inner speech in WM maintenance and updating, we used a within-subject design with three factors. Firstly, participants' capacity to rely on inner speech was manipulated by engaging them in a secondary task during the WM task. The secondary task was either articulatory suppression (i.e. repeating the word "the" following an 80-bpm pace given by a metronome) or foot tapping (at the same pace). The WM task was divided into two blocks of 20 trials according to the secondary task and the order of the blocks was counterbalanced between participants. Secondly, to manipulate WM maintenance demands, we varied the number of pictures that had to be memorized (i.e., two vs four pictures). Finally, to manipulate WM updating demands, we varied the probability of new pictures within a display sequence (i.e. 25% vs 75%).

Figure 1

Schematic Representation of the WM Task



Articulatory Suppression: 20 Sequences (in Randomized Order)			
2 Images (Low Maintenance): 10 Sequences		4 Images (High Maintenance): 10 Sequences	
			
			
25% Updates: 5 Sequences	75% Updates: 5 Sequences	25% Updates: 5 Sequences	75% Updates: 5 Sequences
Foot Tapping: 20 Sequences (in Randomized Order)			
2 Images (Low Maintenance): 10 Sequences		4 Images (High Maintenance): 10 Sequences	
			
			
25% Updates: 5 Sequences	75% Updates: 5 Sequences	25% Updates: 5 Sequences	75% Updates: 5 Sequences

Our preregistered primary outcome variable was mean processing time, which was calculated separately for each trial sequence based on the time participants spent

examining each display within the sequence, excluding the displays with question marks during which participants give their responses. We first excluded all trials with processing times longer than 10 seconds.⁵ After this, processing times that were over or below three standard deviations above the participant's mean were excluded as outliers. We also measured response accuracy by calculating the percentage of correctly remembered pictures for each trial sequence. This was originally done to ensure that the differences between conditions are not caused by a speed-accuracy trade-off.

Questionnaire Measures

After completing the WM task, participants filled in two questionnaires. In the first questionnaire, we asked participants to rate how difficult the task was for them ("easy", "medium", "hard"). We also asked whether participants engaged in self-directed speech – either out loud or silently in their heads – during the task. If they did, they were asked to describe why and what type of things they were saying. Finally, we asked them to rate how useful self-directed speech was for them on a five-point scale ("made the task a lot harder", "made the task a bit harder", "no difference", "helped a bit", "helped a lot").

The second questionnaire was a subscale from the self-control belief measure developed by Job and colleagues (2010), measuring whether participants believed that the willpower required to complete strenuous mental tasks is a limited versus unlimited resource. Participants needed to indicate how much they agreed or disagreed with statements about willpower (e.g., *After a strenuous mental activity, your energy is depleted and you must rest to get it refuelled again.*) using a six-point scale (from "strongly agree" to

⁵ This exclusion criterion was not included in our preregistered analysis plan, but our examination of the data suggested that relying solely on the standard-deviation-based exclusion criteria would have left some extreme outliers in the data.

"strongly disagree"). Each item was scored from 1 to 6 and the final score was derived by calculating the mean of the item scores. The scale showed good internal consistency (Cronbach's $\alpha = .81$).

Statistical Analyses

To examine the role of inner speech in WM, we used linear mixed models. In these analyses, we tested the main effects of the secondary task condition (foot tapping vs articulatory suppression), maintenance demands, and updating demands, as well as the interaction effects of these three variables on processing time.⁶ We controlled for accuracy by including accuracy as a covariate. Additionally, we carried out the same analyses with binomially coded accuracy as the outcome variable. In all the mixed-model analyses, we started with a model that also included all the variables and interaction terms listed above as random effects and then removed them from the random effects step by step starting with the effects with the smallest variance component. We used the Akaike information criterion (AIC) and model deviance to choose the best-fitting model, excluding models with convergence or singularity issues.

We used linear regression to test whether the self-reported use of inner speech predicts the observed effect of articulatory suppression. For each subject, we calculated the difference in mean processing times between articulatory suppression and foot tapping. We then tested whether these difference scores were predicted by self-reported

⁶ Our preregistered analysis plan only included the two-way interactions between the secondary task condition and maintenance demands and the secondary task condition and updating demands, respectively. However, as maintenance and updating demands clearly interacted, we decided to include their interaction as well as the higher-order interaction with all three independent variables in our analyses.

use of self-directed speech. Furthermore, we also examined whether the self-perceived usefulness of self-directed speech is associated with the observed effects of articulatory suppression.

Finally, while our study was primarily designed to examine the role of inner speech in WM subprocesses, we also used linear regression to test whether self-control beliefs predicted mean processing times. Similarly, we conducted a linear regression analysis to test whether self-control beliefs predicted the observed effect of articulatory suppression, using the same difference scores described above.

Results

WM performance: Processing time

The initial model residuals suggested that the normality assumption was violated. Hence, we performed a natural-log transformation for the outcome variable. The best-fitting non-singular model was a model which included participant-specific intercepts, secondary task condition, maintenance demands (2 vs 4 pictures), updating demands (25% vs 75% probability of a new picture), and the interaction between secondary task and maintenance demands as random effects (Table 1). In terms of fixed effects, we observed significant main effects of maintenance demands (standardised coefficient 0.45) and updating demands (standardised coefficient 0.25). As expected, a greater number of pictures and a higher frequency of new pictures were associated with longer mean processing times (Figure 2). Furthermore, there was an interaction between maintenance and updating demands (standardised coefficient 0.07) such that a greater number of pictures affected mean processing times more when there was a higher frequency of new pictures – and vice versa. Surprisingly, articulatory suppression did not appear to slow down processing times significantly more than foot tapping. Moreover, no significant interaction effects were

observed between the secondary task condition and either maintenance or updating demands.

Table 1

Linear Mixed Model Regression: Natural-Log Transformed Processing Times

Fixed effects	Estimate	SE	95% CI		p
			LL	UL	
Intercept	7.521	0.055	7.414	7.629	<.001***
Accuracy	-0.042	0.035	-0.110	0.026	.231
AS	0.017	0.022	-0.026	0.060	.438
Maintenance demands	0.223	0.015	0.194	0.253	<.001***
Updating demands	0.125	0.010	0.106	0.143	<.001***
AS*Maintenance demands	-0.020	0.013	-0.045	0.004	.113
AS*Updating demands	0.006	0.006	-0.005	0.018	.297
Maintenance*Updating	0.037	0.006	0.049	0.026	<.001***
AS*Maintenance*Updating	0.005	0.006	-0.006	0.016	.406
Random effects	Variance	SD			
Intercept	0.088	0.296			
AS	0.020	0.140			
Maintenance demands	0.008	0.090			
Updating demands	0.002	0.050			
AS*Maintenance demands	0.005	0.074			

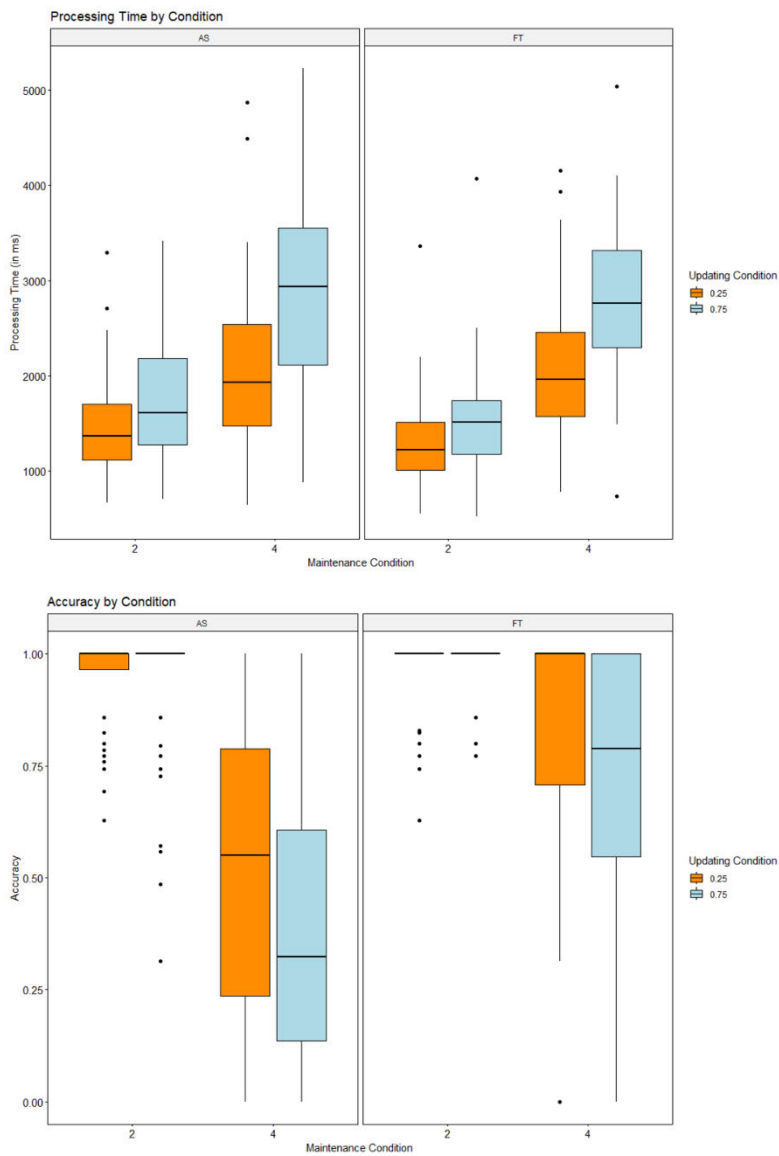
Note. Number of participants = 44, number of observations = 1 735, CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

However, Levene's tests suggested that the assumption of equal variances was not met for the secondary task, maintenance, and updating conditions (all p-values < .004).

Although studies suggest that mixed models can be robust to assumption violations (Jacqmin-Gadda et al., 2007; Schielzeth et al., 2020), the results should be interpreted with caution.

Figure 2

Processing Time and Accuracy in the Articulatory Suppression (AS) and Foot Tapping (FT) Conditions in Study 1.



WM performance: Accuracy

There were notable differences in accuracy between the conditions (Figure 2). Thus, we also run exploratory analyses focusing on accuracy. In these analyses, accuracy was coded as a binomial variable (i.e., whether or not the participant correctly remembered all the pictures in the correct order).

The only mixed binomial regression model that converged was a model with only participant-specific intercepts as random effects (Table 2).⁷ The main effects of maintenance (odds ratio 3.98) and secondary task (odds ratio 1.73) were significant, such that articulatory suppression and an increased number of pictures were associated with poorer accuracy. However, the effect of updating demands was not significant. There was an interaction between the secondary task condition and maintenance demands such that the effect of maintenance demands was stronger in the articulatory-suppression condition (odds ratio 3.24, when averaged over the two updating conditions) than in the foot-tapping condition (odds ratio 2.28). Similarly, there was an interaction between maintenance and updating demands: the effect of updating demands was only significant in the four-picture condition (odds ratio 0.78, when averaged over the two secondary task conditions) and the effect of maintenance demands was stronger in the 75%-updating condition (odds ratio 3.24) than in the 25%-updating condition (odds ratio 2.28). There was no interaction between the secondary task condition and updating demands.

Assumption checks suggested that the final model did not substantially deviate from the normal distribution and that there was no significant overdispersion ($p=.94$) or

⁷ Our original models included processing time as a control variable. However, none of these models converged. Thus, the accuracy analyses were carried out without controlling for processing time.

multicollinearity (variance inflation factors for all predictor variables < 1.1). However, when trying to conduct sensitivity analyses using simulated data, we run into singularity issues, suggesting that the number of trials per condition may have been insufficient.

Table 2

Binomial Mixed Model Regression: Accuracy

Fixed effects	Estimate	SE	95% CI		p
			LL	UL	
Intercept	1.966	0.166	1.641	2.292	<.001***
AS	-0.549	0.094	-0.733	-0.365	<.001***
Maintenance demands	-1.381	0.097	-1.570	-1.191	<.001***
Updating demands	-0.153	0.093	-0.335	0.030	.101
AS*Maintenance demands	-0.239	0.093	-0.422	-0.056	.010*
AS*Updating demands	-0.101	0.093	-0.284	0.081	.275
Maintenance*Updating	-0.240	0.093	-0.422	-0.057	.010*
AS*Maintenance*Updating	0.094	0.093	-0.088	0.276	.312
Random effects	Variance	SD			
Intercept	0.7708	0.878			

Note. Number of participants = 44, number of observations = 1 735, CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Metacognitive awareness of inner speech

Almost every participant (42 out of 44) reported using either audible self-directed speech or inner speech during the task. Thus, we could not test whether self-reported use of self-directed speech correlated with the observed effects of articulatory suppression. More specifically, 28 participants reported using private speech and 38 participants reported inner speech. In general, participants were aware of whether they used private speech. There were only three participants who reported they had not spoken out loud during the task but whose report was contradicted by the audio recordings. Unfortunately, due to

technical issues, most participants did not get the follow-up questions regarding the self-perceived usefulness of self-directed speech. Hence, we could not test whether the self-perceived usefulness of self-directed speech was associated with the observed effects of articulatory suppression.

Self-control beliefs

No correlation was found between self-control beliefs and overall processing speed ($r=.07$, $p=.63$) or accuracy ($r=.10$, $p=.52$) in the WM task when examining mean values by participant. Similarly, there was no association between self-control beliefs and the difference in processing times between the articulatory-suppression and foot-tapping conditions ($r=.17$, $p=.28$). There was also no association between self-control beliefs and the difference in accuracy between the articulatory-suppression and foot-tapping conditions ($r=-.23$, $p=.13$). The result remained the same when we conducted processing time analyses including only trials with correct responses, and when we controlled for accuracy in the processing time analyses – and vice versa (all p-values $>.10$). Finally, we conducted an exploratory learning curve analysis to examine whether self-control beliefs would affect interact with how participant's accuracy developed over time (see Appendix). However, we found no evidence of either the main effect of trial number or its interaction with the self-control belief score.

Summary and Discussion

Study 1 provided a first test of whether inner speech impacts working memory maintenance and updating. Our pre-registered analysis focused on processing times, and here we only found the main effects of maintenance and updating demands, with no significant impact of articulatory suppression either on its own or in interaction with maintenance or updating demands. However, the manipulations in this paradigm also generated far more variance in accuracy than we had expected. Exploratory analyses

again indicated significant effects of maintenance and updating, but also an interaction effect between articulatory suppression and maintenance demands, which is consistent with prior evidence for the role of inner speech in information maintenance (Alderson-Day & Fernyhough, 2015; Baddeley, 2012).

Interestingly, a similar interaction was not observed for articulatory suppression and updating demands. The cause of this null effect is unclear. It may be that inner speech is not utilised in WM updating and hence disrupting inner speech with articulatory suppression does not affect participants' performance under increasing updating demands. However, it may also be the result of a methodological flaw, in that the main effect of updating demands was smaller than the main effect of maintenance demands, meaning that our power to detect an interaction with articulatory suppression was necessarily low.

Finally, we did not find any clear patterns in our analyses of both participants' metacognitive awareness and their self-control beliefs. We could not test our hypotheses regarding participants' metacognitive awareness of self-directed speech due to technical issues and the lack of variation in the use of verbal strategies in the WM task. Meanwhile, there was no correlation between self-control beliefs and either overall WM performance or the use of inner speech.

Given the small effect of updating demands in Study 1, we decided to carry out a second study with a greater difference in updating demands across conditions to further examine the effect of articulatory suppression on WM performance.

Study 2

Method

Participants

The final sample of Study 2 included 49 university students (41 Female; $M_{Age}=19.7$, $SD=5.0$) living in the United Kingdom. As in Study 1, the target sample size of 50

participants was decided primarily based on resource constraints. All participants were recruited through a student volunteer panel of the University of Edinburgh and received course credits for their participation. Most participants (80%) were native English speakers. Similarly to Study 1, the exclusion rate was high: 42 participants had to be excluded, mainly for not following the instructions ($n=22$) and/or providing audible responses ($n=20$). Additionally, two participants failed the attention check included in the self-control belief scale and were thus excluded from analyses focusing on self-control belief scores.

Procedure

In Study 2, we modified the WM task such that the main effect of updating demands would be bigger, allowing us a better chance to detect the hypothesized interaction effect between updating demands and secondary task condition. Moreover, we fixed a coding mistake that had caused the metacognitive questionnaire to skip follow-up questions. Apart from these changes, Study 2 followed the design of Study 1 described above.

Measures

We used the same WM task as in Study 1. However, we increased the contrast between the two updating conditions. In Study 1 the probability of a new picture within a display sequence was 25% in the low updating demand condition and 75% in the high updating demand condition. In Study 2, these probabilities were 10% and 90%, respectively.

After completing the WM task, participants were asked to fill in the same questionnaires as in Study 1. The self-control belief scale continued to show acceptable internal consistency (Cronbach's $\alpha = .79$).

Results

WM performance: Accuracy

The means by condition (Figure 3) suggested that the differences in accuracy were indeed more pronounced than in Study 1. As none of the models which included processing time as a predictor converged, we conducted the analyses without this control variable. The only model which converged was the model that included only intercept as random effects (Table 3). This model suggested that the main effects of maintenance demands (odds ratio 5.16), secondary task condition (odds ratio 2.34), and updating demands (odds ratio 1.67) were significant, such that articulatory suppression, an increased number of pictures and a higher frequency of new pictures were all associated with poorer accuracy. However, there were no significant interaction effects.

Assumption checks suggested that the model did not substantially deviate from the normal distribution and that there was no significant overdispersion ($p=.87$) or multicollinearity (variance inflation factors for all predictor variables < 1.2).

WM performance: Processing time

We also conducted an exploratory analysis of processing times using linear mixed models. Similar to Study 1, the outcome variable was log-transformed because the initial model residuals without log-transformation suggested that the normality assumption was violated. The best-fitting non-singular model was a model which included the intercepts, secondary task condition, maintenance demands, and updating demands, as well as the secondary task*maintenance and maintenance*updating interactions as random effects (Table 4). In the fixed effects, we observed the main effects of maintenance demands (standardised coefficient 0.46) and updating demands (standardised coefficient 0.42), but no main effect of the secondary task. Critically, there was a small but significant interaction effect of secondary task and updating demands (standardised coefficient 0.03). That is, the

detrimental effect of updating demands on processing time was stronger during articulatory suppression.

Figure 3

Processing Time and Accuracy in the Articulatory Suppression (AS) and Foot Tapping (FT) Conditions in Study 2

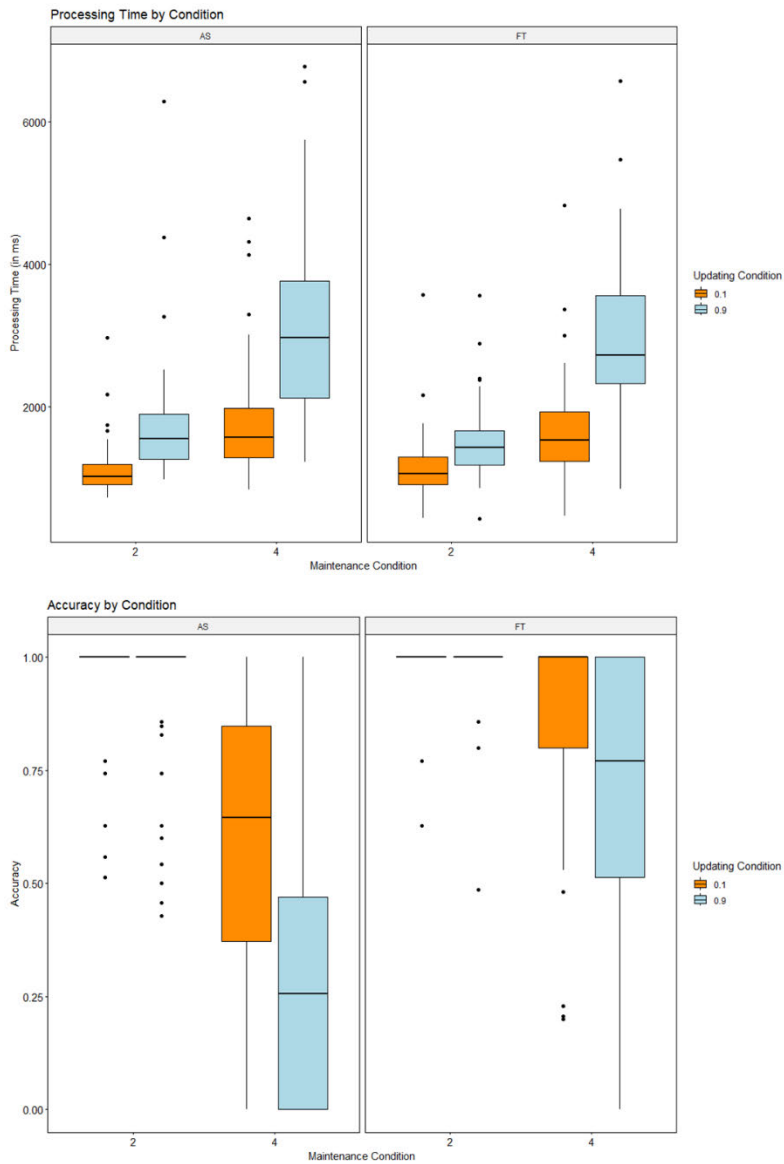


Table 3*Binomial Mixed Model Regression: Accuracy*

Fixed effects	Estimate	SE	95% CI		<i>p</i>
			<i>LL</i>	<i>UL</i>	
Intercept	2.313	0.201	1.919	2.708	<.001***
AS	-0.851	0.114	-1.075	-0.627	<.001**
Maintenance demands	-1.641	0.120	-1.877	-1.405	<.001***
Updating demands	-0.514	0.113	-0.735	-0.293	<.001***
AS*Maintenance demands	-0.098	0.113	-0.320	0.123	.383
AS*Updating demands	-0.022	0.112	-0.242	0.198	.844
Maintenance*Updating	-0.167	0.112	-0.388	0.053	.137
AS*Maintenance*Updating	-0.049	0.112	-0.269	0.171	.662
Random effects	Variance	SD			
Intercept	1.228	1.108			

Note. Number of participants = 49, number of observations = 1 925, CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

In contrast, there was no interaction effect of secondary task and maintenance. In addition, there was an interaction effect of maintenance and updating demands (standardised coefficient 0.10) and a three-way interaction effect of all three independent variables (standardised coefficient -0.03). Maintenance demands affected processing time more in the 90%-updating condition than in the 10%-updating condition, and updating demands affected processing time more in the four-picture condition than in the two-picture condition. Moreover, this interaction was stronger in the foot-tapping condition than

in the articulatory-suppression condition. However, Levene's tests suggested that the assumption of equal variances was not met for any of our predictor variables (all p-values < .02). Additionally, our simulations again indicated that the small number of trial sequences might lead to singularity issues, making valid sensitivity analyses difficult.

Self-control beliefs

As in Study 1, no correlation was found between self-control beliefs and overall WM performance in terms of processing speed ($r=.10$, $p=.49$) or accuracy ($r=.13$, $p=.37$), when examining mean values by participant. Similarly, there was no association between self-control beliefs and the difference in processing times between the articulatory-suppression and foot-tapping conditions ($r=-.09$, $p=.54$). Finally, there was also no association between self-control beliefs and the difference in response accuracy between the two secondary task conditions ($r=-.18$, $p=.23$). This pattern of results did not change when we conducted regression analyses in which controlled for accuracy when examining processing time and vice versa – nor when we used only trials with fully accurate responses in the processing time analyses (all p-values > .15). Again, we also conducted an exploratory learning curve analysis (see Appendix). However, the results remained inconclusive as the models with key control variables did not converge.

Summary and Discussion

In Study 2, we now observed an interaction effect of articulatory suppression and updating demands on processing speed – in addition to the main effects of maintenance and updating demands – suggesting that inner speech can support WM updating. However, in contrast to Study 1, we found no interaction effects between articulatory suppression and either maintenance or updating demands on accuracy in the WM task. When examining accuracy, our analysis only showed the main effects of articulatory suppression, maintenance demands, and updating demands.

Table 4*Linear Mixed Model Regression: Natural-Log Transformed Processing Times*

Fixed effects	Estimate	SE	95% CI		<i>p</i>
			<i>LL</i>	<i>UL</i>	
Intercept	7.400	0.051	7.300	7.500	<.001***
Accuracy	-0.009	0.033	-0.074	0.055	.977
AS	0.028	0.022	-0.015	0.072	.204
Maintenance demands	0.248	0.015	0.218	0.277	<.001***
Updating demands	0.227	0.012	0.205	0.250	<.001***
AS*Maintenance demands	-0.006	0.009	-0.024	0.012	.494
AS*Updating demands	0.016	0.005	0.005	0.027	.004**
Maintenance*Updating	0.053	0.008	0.037	0.068	<.001***
AS*Maintenance*Updating	-0.016	0.005	-0.027	-0.005	.003**
Random effects	Variance	SD			
Intercept	0.084	0.290			
AS	0.022	0.149			
Maintenance demands	0.009	0.096			
Updating demands	0.005	0.071			
AS*Maintenance demands	0.003	0.051			
Maintenance*Updating	0.002	0.039			

Note. Number of participants = 49, number of observations = 1 925, CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Regarding the metacognitive questionnaire, our second sample further suggested that adult participants almost invariably report using self-directed speech. Furthermore, an overwhelming majority of the participants evaluated that self-directed speech helped them

in the WM task, and no association was observed between the self-perceived usefulness of self-directed speech and the effect of articulatory suppression. Finally, as in Study 1, we did not find any evidence of an association between self-control beliefs and either overall WM performance or the use of inner speech.

General Discussion

In these two experiments, we studied the potential role of inner speech in WM maintenance and updating. We combined a visual WM task with a dual-task design and compared participants' performance during articulatory suppression and a non-verbal secondary task. We also aimed to examine whether differences in inner speech use and task performance were related to participants' metacognitive awareness of self-directed speech and their beliefs about self-control.

Our results provide preliminary support for the role of inner speech in WM updating. In Study 2, we observed that the effect of updating demands on processing time was moderated by articulatory suppression. Frequent updates slowed participants' performance down more when inner speech was disrupted. This suggests that, in addition to being a memory cue and supporting WM maintenance, the linguistic code of inner speech may indeed facilitate the efficient manipulation of task-relevant representations (see Kompa & Mueller, 2020). We did not observe a similar interaction between articulatory suppression and updating demands when examining accuracy. However, as our manipulation of updating frequency was less effective than our manipulation of memory load, an alternative explanation is that the main effect of updating demands was simply too weak for us to detect significant interaction. Indeed, even in processing time, the effect of articulatory suppression on updating was observed only when we compared conditions with very low and very high updating probabilities (10% vs 90%). The effect of updating demands on WM performance may not be linear – at least in the task used in our

studies. More frequent updates increased the need for active manipulation of information during the trials, but they also decreased the length of time participants needed to maintain a specific set of items in their WM. Thus, updating demands might only become detrimental to performance after a certain threshold. This, in turn, would make it harder for studies like ours to detect the interactions between updating demands and articulatory suppression – whether or not inner speech is involved in updating. Future studies could examine this possibility by systematically varying updating demands.

The extent to which language mediates cognition is a long-standing topic of controversy in both psychology and philosophy (see Cragg & Nation, 2010; Lupyan, 2016). Our present finding that inner speech can support WM updating is in line with theoretical accounts and empirical research which highlight the role of language as an efficient code that can support information processing in domains that are not inherently verbal, such as visual perception (Lupyan et al., 2020). In addition to articulatory rehearsal associated with information maintenance, language may offer a general code that – in the form of inner speech – can boost the manipulation of task-relevant information. If future studies replicate our results, this finding can be relevant for several research domains within cognitive psychology. For example, cross-sectional studies suggest that age-related differences in cognitive control are partly explained by WM performance (Gonthier et al., 2019; Kubota et al., 2020; Troller-Renfree et al., 2020; Wang et al., 2021). Furthermore, this relation between WM performance and cognitive control may be mediated by WM updating (Troller-Renfree et al., 2020; see also Amso et al., 2014). Hence, future studies could investigate whether cognitive control development is supported by increasing utilisation of inner speech in information updating.

As expected, varying maintenance demands affected WM performance in terms of both speed and accuracy. Surprisingly, articulatory suppression did not increase the effect

of maintenance demands on processing time. Instead, in Study 2, we observed an unexpected three-way interaction. Across the two studies, maintenance demands affected processing time more when the updating demands were high and vice versa. While these two manipulations were designed to affect different WM subprocesses, it is unsurprising that increasing one type of WM processing demand also leaves participants more vulnerable to increases in another type of WM processing demand. However, in Study 2, this interaction was stronger during foot tapping than during articulatory suppression. A possible interpretation of these results is that disrupting inner speech weakened the reciprocal interaction between maintenance and updating demands by selectively increasing the effect of updating demands on processing time independently of maintenance demands.

By contrast, when examining accuracy, we did observe an interaction between articulatory suppression and maintenance demands – although this effect was only significant in Study 1. This pattern of findings - articulatory suppression affecting information updating in terms of processing time and information maintenance in terms of accuracy – could be seen as consistent with the hypothesised underlying mechanisms. If inner speech supports information maintenance in the form of articulatory rehearsal of verbal memory cues (Alderson-Day & Fernyhough, 2015; Baddeley, 2012), it could indeed help participants to remember items more accurately but might not necessarily lead to faster processing speed. By contrast, if the role of inner speech in updating information is related to the fact that verbal representations allow more efficient processing (Kompa & Mueller, 2020; Lupyan & Swingley, 2012), this could specifically affect processing speed. That said, we did not expect this pattern of findings and these post-hoc interpretations are speculative. The inconsistent pattern of findings may also be an artefact caused by experiment-specific factors. Further research would be needed to test this hypothesis.

Unlike the robust effects of maintenance and updating demands on performance in terms of both speed and accuracy, the effect of articulatory suppression was less pronounced than we expected. This is somewhat surprising, considering that the effect of articulatory suppression has been consistently demonstrated in previous literature with a diverse set of executive functioning tasks (see Alderson-Day & Fernyhough, 2015). The most obvious difference between this earlier research and our studies is that our studies were conducted online without real-time monitoring. Although we were able to evaluate secondary task engagement retrospectively when analysing the audio recordings, the unsupervised and uncontrolled setting may have created extra noise in our data. On the other hand, the previous studies may also have overestimated the true effect of articulatory suppression.

Overall, there was substantial variance between participants in the mean speed and accuracy. Across the two studies, our mixed models with processing time as an outcome variable consistently highlighted the participant-specific variation in the main effects of maintenance demands and articulatory suppression as well as the interaction effect of articulatory suppression and maintenance demands. Although these models had heteroscedasticity issues, this observation has implications for future research. Studies with larger sample sizes might be needed to detect more consistent patterns amid individual differences. Moreover, studies with larger sample sizes could also look for potential subgroups to see whether there are distinct profiles in how people's WM subprocesses are affected by articulatory suppression and whether these data-driven profiles are associated with specific background characteristics. Many characteristics could potentially affect how people respond to increasing maintenance demands and the disruption of inner speech (e.g., genetic profiles or socioeconomic status).

Our second objective was to examine whether inner speech engagement would relate to participants' metacognitive awareness of self-directed speech. Almost all our participants reported using self-directed speech in the WM task and they almost invariably found these verbal strategies helpful. This lack of variance made it impossible to test whether or not metacognitive awareness of self-directed speech would relate to inner speech engagement and performance. Nevertheless, our study provides valuable empirical evidence of a topic that has been so far mainly studied in children and adolescents (e.g., Flavell et al., 1997; Manfra & Winsler, 2006; Winsler & Naglieri, 2003) by showing that adult participants were aware of their self-directed speech and found it helpful. When responding to the open-ended questions about the content of their self-directed speech, a small minority of our participants reported verbal strategies that relied on semantic or phonetic associations (e.g., creating a story based on the pictures) instead of just repeating what they saw. Due to our limited sample size, we were unable to test whether these differences were associated with differences in WM performance or the effect of articulatory suppression. Research suggests that self-generated internal memory cues can effectively support long-term memory (Tullis & Finley, 2018). However, relatively complex memory cues might be less cost-effective in WM tasks as they do not require long-term memory retrieval.

Finally, we found no association between participants' self-control beliefs and either their WM performance or the effect of articulatory suppression. Previous studies have found evidence that self-control beliefs affect participants' performance in executive functioning tasks, including WM tasks (e.g., Job et al., 2010; Miller et al., 2012). Furthermore, some have suggested that viewing self-control as a nonlimited resource could motivate people to try out various strategies to complete a demanding task (Haimovitz et al., 2020). That said, the potential effect of self-control beliefs may be more

specific than we expected, leaving our task design and outcome measures unsuitable for detecting it. For example, the experiments that first demonstrated the effect of self-control beliefs on executive functioning used paradigms in which participants had to perform several consecutive tasks, and the first task had specifically been designed to be strenuous and depleting (Job et al., 2010). Although our WM task was time-consuming and included two trial blocks, the participants in our study still only had to complete one task.

Similar to our studies, Miller et al. (2012) used a single WM task, but their analyses focused on participants' learning curves over time rather than their mean performance. When we conducted explorative learning curve analyses with the present data, the results were inconclusive (see Appendix) as our task design and sample size were not well-suited for such analyses. More research is thus needed to further investigate the association between self-control beliefs and executive functioning. It is possible that unlimited beliefs do indeed affect WM performance in extended, demanding task conditions but that our research design did not allow us to uncover this effect, as our task was primarily designed to examine the role inner speech in different WM subprocesses.

Strengths and Limitations

In contrast to most previous studies on inner speech and WM, these studies used a task that was designed to disentangle two WM subprocesses: maintenance and updating. Moreover, compared to earlier studies using the running memory paradigm (Morris & Jones, 1990; Yue et al., 2008), our studies had a larger sample size and thus more statistical power to detect the hypothesized effects of articulatory suppression. In addition, our studies included a metacognitive questionnaire that allowed us to examine participants' self-reported use of verbal strategies. Finally, to our knowledge, the role of inner speech in WM subprocesses has not been studied with an online design before.

That said, the online design also led to some limitations. As noted above, participants completed the task unsupervised. When participants' engagement in the secondary task was later checked through audio recordings, we found that many of them did not follow the instructions or provide valid responses. This led to a high exclusion rate, and differences in the settings in which participants conducted the task may have also caused additional noise in our data compared to more controlled laboratory experiments. Moreover, to keep the total duration of the task tolerable, we did not include a third condition without any secondary task. Hence, while we could test the difference between the articulatory-suppression and foot-tapping conditions, we could not empirically test whether participants would have performed better without any secondary task. Although previous in-person studies have consistently demonstrated such an effect (e.g., Baddeley et al., 2001; Emerson & Miyake, 2003; Saeki et al., 2013), future research should further verify that the same effect can also be observed in online studies.

Our sample sizes were larger than in the earlier studies on inner speech and WM subprocesses. That said, the fact that most of our statistical models failed to converge suggests that our studies may still have been under-powered for the type of complex mixed-effect models we were aiming to use. Indeed, due to technical issues, each of our studies included less than 50 participants. More importantly, our research design provided us with only five trial sequences per each condition – and for many participants had some trial sequences which had to be excluded. Indeed, our simulation analyses suggested that fitting the present models with such a small number of trials per condition would lead to singularity issues. This may have limited our ability to rigidly detect meaningful effects. Yet, with the present design, it would have been difficult to increase the number of trial sequences without making the task duration overly exhausting.

Furthermore, our studies relied on a single WM task. While there is evidence of a general WM factor, the content of a specific task clearly affects performance (e.g., Redick & Lindsay, 2013; Waris et al., 2017). From the perspective of inner speech, the most obviously relevant division is between verbal and non-verbal WM tasks. However, it is possible that even within non-verbal tasks, differences in task design may affect people's reliance on inner speech. Future studies should investigate the role of inner speech in WM maintenance and updating using a diverse range of different types of WM tasks as well as more ecologically valid measures of participant's performance in real-life tasks. Relatedly, as stated above, the present experimental design was not ideal for examining the relationship between self-control beliefs and executive functioning. Testing this association more rigidly would require studies with simpler task design and larger sample size.

Conclusion

Our findings suggest that the role of inner speech in WM processing is not solely limited to WM maintenance, but it can also support the efficient updating of the relevant information. Based on our questionnaire data, almost all participants used self-directed speech and found it helpful. In contrast to previous research on self-control beliefs and executive function tasks, there was no association between self-control beliefs and WM performance. A more fine-grained understanding of the role of inner speech in WM subprocesses can eventually help us refine our theories about how language mediates cognition and allow us to better support groups with impaired or altered verbal and non-verbal cognitive functioning.

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Appendix: Exploratory Learning Curve Analyses

Study 1

We examined learning effects in accuracy with linear mixed-model regression, using processing time as a control variable. Processing times were natural log-transformed and self-control belief scores standardised to yield an identifiable model. The only model which converged was the model that included only participant-specific intercepts as random effects (Table A1). The results suggested that there was a very small but nominally significant with trial number (odds ratio 1.02), indicating a slight increase in accuracy over time. However, there was no significant interaction between this learning effect and self-control beliefs. Moreover, when we run the same analyses including block order as a control variable, there was no significant main effect of trial number or self-control beliefs, and we found no interaction effect either. Considering the overall high accuracy, the apparent lack of any meaningful learning during the task may result from a ceiling effect.

Study 2

Similar to Study 1, the only model which converged was the model that included only participant-specific intercepts as random effects (Table A2). Again, the main effect of trial number suggested a very small but nominally significant increase in accuracy over time (odds ratio 1.01). Moreover, in Study 2 there was a significant main effect of self-control beliefs (odds ratio 1.80), such that participants with who scored higher on the scale (i.e., had a more limited view of self-control) had more accurate responses overall. Finally, there was also an interaction between trial number and self-control beliefs such that participants who scored lower on the self-control belief scale (i.e., had a less limited view of self-control) showed a greater increase in accuracy over time. However, we could not test whether this effect would also be observed after controlling for the processing time and block order, as none of the models including these control variables converged.

Table A1*Binomial Mixed Model Regression: Accuracy by Trial Number in Study 1*

Fixed effects	Estimate	SE	95% CI		<i>p</i>
			<i>LL</i>	<i>UL</i>	
Intercept	14.932	1.348	12.290	17.574	<.001***
Time (log-transformed)	-1.745	0.170	-2.078	-1.411	<.001***
Trial number	-0.018	0.006	-0.028	-0.007	.002**
Beliefs (standardised)	-0.288	0.179	-0.639	0.062	.107
Trial number*Beliefs	0.010	0.005	-0.001	0.020	.075
Random effects	Variance	SD			
Intercept	0.754	0.868			

Note. Number of participants = 44, number of observations = 1 735, CI = confidence interval; *LL* = lower limit; *UL* = upper limit; Time = processing time (log-transformed); Beliefs = score on the self-control belief scale (standardised)

Table A2*Binomial Mixed Model Regression: Accuracy by Trial Number in Study 2*

Fixed effects	Estimate	SE	95% CI		<i>p</i>
			<i>LL</i>	<i>UL</i>	
Intercept	16.060	1.233	13.644	18.476	<.001***
Time (log-transformed)	-1.911	0.156	-2.217	-1.606	<.001***
Trial number	-0.017	0.006	-0.028	-0.006	.038*
Beliefs (standardised)	0.586	0.198	0.198	0.973	.003**
Trial number*Beliefs	-0.021	0.005	-0.032	-0.011	<.001***
Random effects	Variance	SD			
Intercept	1.177	1.085			

Note. Number of participants = 49, number of observations = 1 925, CI = confidence interval; *LL* = lower limit; *UL* = upper limit; Time = processing time (log-transformed); Beliefs = score on the self-control belief scale (standardised)

In this chapter, I have presented preliminary evidence suggesting that the role of inner speech – self-directed speech without audible articulation – in working memory processing is not solely limited to information maintenance. Rather, verbal representations may also support the efficient updating of the relevant information. That is, in addition to articulatory rehearsal associated with information maintenance, language may offer an efficient code that can boost the manipulation of task-relevant information in the form of inner speech. If future studies replicate our results, this finding can open up new avenues of research with respect to both EF and self-control. By contrast, in contrast to my hypotheses, I found no association between self-control beliefs and either overall working memory task performance or verbal strategy use.

In the next and final chapter, I will discuss the theoretical and practical implications of my empirical chapters for research on self-control, metacognition, and strategy use. I will also further address the relationship between self-control and EF.

Chapter 5 Discussion

Motivational conflicts are a ubiquitous feature of our daily lives. Whether we are striving to earn a degree, maintain a healthy diet, or preserve social relationships, self-control is needed to resolve conflicts between our commitments and competing, contradictory motives. In the present dissertation, I have presented five studies that examined self-control, metacognition, strategies, EF, and the interactions between them. I began by studying the structure of self-control beliefs, demonstrating that people's beliefs about the short-term limitedness and long-term malleability of self-control are relatively independent from each other and providing new insights into how these belief dimensions relate to other psychological phenomena (Chapter 2). I then examined how people's metacognitive beliefs are affected by whose self-control they are thinking about and found strong effects of ADHD diagnosis on people's beliefs about both their own and other people's self-control (Chapter 3). By contrast, I found no consistent associations between self-control beliefs and the use of different self-control strategies. Finally, I investigated metacognition and strategy use in the context of specific EF subprocesses (Chapter 4). Here, I found no association between self-control beliefs and EF performance. However, the experiments highlighted the role of verbal strategies in EF, providing preliminary evidence of a general processing advantage related to verbal representation.

In this final chapter, I will discuss the theoretical and practical implications of this dissertation for the research on self-control beliefs. I will then proceed to consider the association between metacognitive beliefs and self-control performance as well as the potential conceptual and methodological challenges related to empirically assessing this association. After covering these more general questions, I will specifically focus on the effect of ADHD on metacognitive beliefs. Lastly, I will address questions related to the relationship between self-control and EF – focusing on the association between self-

control beliefs and EF as well as the parallel theoretical developments in self-control and EF research.

5.1 The Structure of Self-Control Beliefs

Previous research on self-control beliefs has focused on examining whether self-control is viewed as a limited versus nonlimited resource in the short term (see Francis & Job, 2018; Li et al., 2024). In the present dissertation, I contrasted these limitedness beliefs with another belief dimension: whether self-control is seen as fixed versus malleable in the long term. As suggested by earlier findings from consumer research (Mukhopadhyay & Johar, 2005; Mukhopadhyay & Yeung, 2010), short-term limitedness beliefs and long-term malleability beliefs appear relatively independent from each other.

In addition to being multidimensional, self-control beliefs seem to be relatively domain-specific. The subscales measuring limitedness beliefs in different self-control domains – exerting mental effort versus resisting temptations – were only moderately correlated with each other in the first study and there was no significant correlation between them in the second study. The PCAs similarly suggested that mental-effort and resisting-temptation items primarily loaded on different components. Other studies have reported similar findings when examining limitedness beliefs in different self-control domains (Bernecker & Job, 2017; Jędrzejczyk & Zajenkowski, 2020). Further research is needed on whether malleability beliefs are similarly domain-specific. The present studies could not address this question as they only included one subscale for measuring malleability beliefs and its items were worded in a general, abstract manner that was adapted from the established measure for implicit theories of intelligence (Dweck, 1999).

The domain specificity of limitedness beliefs has mixed implications for the validity of the scale. On the one hand, this may offer ways to increase prediction accuracy. Earlier studies conducted with Swiss participants found that people had different expectations

about their self-control or willpower for exerting mental effort, resisting temptations, and controlling one's emotions (Bernecker & Job, 2017). Whether exerting self-control had a negative effect on subsequent self-control performance depended on a person's domain-specific beliefs. Thus, focusing on the relevant self-control domain can increase predictive power. On the other hand, the inconsistent correlations between the limitedness subscales across studies raise questions about the structural validity of the scale. As noted in Chapter 2, on a more fundamental level, one might even ask whether it makes sense to discuss the measurement of "self-control beliefs" or "willpower theories". This type of phrasing may give the impression that there is some common core to people's beliefs across different domains. Should we perhaps abandon such language and consider people's beliefs about strenuous mental tasks, resisting temptations, and emotion regulation completely independently from each other?

The fact that associations between subscales seem to vary from sample to sample without a clear explanation is obviously an issue from a psychometric perspective. Here, it is important to note that the inconsistent correlations found in the present studies might partly reflect limitations in statistical power and studies with larger sample sizes are still needed to further investigate the issue. However, even if future research further suggests that self-control beliefs are indeed profoundly domain-specific, this does not necessarily mean that the whole research project should be reframed. There would still be a theoretical rationale for considering various distinct behaviours as self-control if they involve self-regulation in the face of a motivational conflict (Koi, 2023; see also Fujita et al., 2025; Goschke & Job, 2023). The domain specificity of people's beliefs has practical implications to both scale development and our understanding of how metacognitive beliefs relate to behaviour. That said, this finding alone is not a sufficient reason for giving up on the whole concept of self-control.

Chapter 2 also points to another structural validity concern: the PCAs suggested that items reflecting limited versus nonlimited beliefs loaded to different components. That is, reverse-coded and non-reverse-coded items appeared to function differently. Somewhat similar results have previously been found in US samples (Napolitano & Job, 2018). Although the existing literature has generally assumed that statements expressing limited and nonlimited views of self-control represent the opposite ends of the same continuum, they might not form a single dimension in people's lay beliefs. A similar possibility has been discussed in the literature on lay beliefs and implicit theories about other psychological attributes, such as intelligence (see Lüftenegger & Chen, 2017). Such findings suggest that, in contrast to researchers' theoretical assumptions, people's responses about the fixedness or malleability of a given attribute do not necessarily form a single dimension but might better be understood as two separate dimensions. While these kinds of apparent contradictions might simply reflect response biases caused by item wording, it is also possible that people do in fact hold contradictory beliefs about the nature of psychological attributes.

In sum, these findings raise some questions about our understanding of the structure of self-control beliefs and the validity of the scale used in the present studies. Examining short-term limitedness and long-term malleability beliefs together and taking into account the domain-specific nature of such beliefs offers a more nuanced approach to studying people's metacognition about self-control. This approach may allow a more detailed understanding of how metacognitive beliefs shape self-control performance. However, this is hardly an all-encompassing model of self-control beliefs. Quantitative studies with multiple-choice items have their inherent limitations. The present dissertation focused on two potential dimensions of metacognitive beliefs, which were chosen based on previous research (see Dweck & Yeager, 2019; Francis & Job, 2018; Li et al., 2024).

Future research may benefit from combining quantitative and qualitative methods to explore the extent to which the two-dimensional approach inherent in the current scales accurately summarises the ways in which lay people reason about self-control and other psychological phenomena.

Indeed, a recent study used open-ended questions to examine lay beliefs about self-control in participants from three different countries (Li et al., 2025). The qualitative approach led the researchers to propose a framework with 14 key components of self-control beliefs, offering a richer view of the phenomenon. That said, this pioneering work also demonstrates some of the challenges related to carrying out this type of research. For example, despite the open-ended response format, the questionnaire used in the study started with a preselected definition of self-control formulated by the researchers. Hence, even this approach was not entirely bottom-up. Moreover, the predictive value of the identified key components is left unclear as only one of the 14 components correlated significantly with trait self-control, which was used as a measure of people's actual self-control ability. Thus, further work is still needed in combining open-ended and multiple-choice approaches and balancing their respective benefits and limitations.

5.2 Construct and Predictive Validity

One of the goals of the present dissertation was to examine how self-control beliefs are associated with other, conceptually related psychological phenomena. In Chapter 2, I found negative correlations between general self-efficacy and limited and fixed self-control beliefs. Previous research with the limitedness subscales has yielded similar results (Bernecker et al., 2017; de Ridder et al., 2020). Furthermore, Study 1 in Chapter 2 suggested that limitedness beliefs were also moderately associated with weaker general self-esteem, whereas no significant correlation was found between self-esteem and malleability beliefs.

Both self-efficacy and self-esteem have been consistently associated with important behavioural outcomes in real life (see Honicke & Broadbent, 2016; Muris & Otgaar, 2023). Future research could examine the potential dynamics underlying the observed associations between self-control beliefs and these more established psychological attributes. For example, the present findings offer preliminary evidence that malleability beliefs may be specifically associated with general self-efficacy but not with self-esteem. As noted in Chapter 2, it has been previously suggested that self-efficacy is more closely linked to motivational constructs and self-esteem to affective constructs (Chen et al., 2004). If future research provides more evidence for the specific association between malleability beliefs and self-efficacy, malleability beliefs might be an especially relevant research topic for motivational research.

On the other hand, the correlations between self-control beliefs and general self-efficacy or self-esteem were only weak-to-moderate. This supports the construct validity of the self-control beliefs scale: the subscales are measuring something distinct from more general self-related attitudes. Such distinctions open the possibility that self-control beliefs, self-esteem, and self-efficacy may also be independently associated with self-control performance and other behavioural outcomes. There is already preliminary empirical evidence supporting this idea. A longitudinal diary study conducted in the Netherlands found that self-control beliefs and self-efficacy both independently predicted change in self-reported self-control capacity over a period of several months (de Ridder et al., 2020).

Beliefs about the malleability of self-control were moderately correlated with similar beliefs about overall personality, but not with beliefs about intelligence. Previous studies have generally tended to find weak-to-moderate correlations between malleability beliefs about different psychological attributes, such as intelligence, personality, or emotion (e.g., Schroder et al., 2015; Spinath et al., 2003; Zhu et al., 2020). The present results

complement this existing research by further suggesting that people's beliefs about the malleability of different psychological attributes are not fully independent from each other. Yet, people do not seem to hold generalised malleability beliefs that they would apply across psychological phenomena. Instead, these metacognitive beliefs appear to be domain-specific.

Interestingly, explorative analyses indicated that people viewed self-control as more malleable than intelligence or overall personality and that intelligence was rated as more malleable than personality. People may view more specific characteristics and abilities, such as self-control and intelligence, as more malleable than the fundamental core of "what kind of person one is". Furthermore, the difference between self-control and intelligence beliefs might indicate that people view self-control more as a process and intelligence more as a trait. However, more research is needed to test these hypotheses. It is also important to note that the present research was conducted with UK participants, and there may be cultural differences in how psychological phenomena such as self-control or intelligence are understood (see Li et al., 2025; Savani & Job, 2017; Sun et al., 2021a; 2021b).

The distinctions between malleability beliefs about different attributes may also have implications for predictive validity. Earlier studies suggest that malleability beliefs about different psychological phenomena are distinctly associated with behavioural outcomes. For example, a Chinese study examined malleability beliefs about six psychological attributes (i.e., intelligence, personality, cognition, feeling, behaviour, and emotion) in university students (Zhu et al., 2020). Beliefs about different attributes were differently associated with coping-related psychological phenomena and study performance. Moreover, a study with US university students found that malleability beliefs about anxiety, emotion, intelligence, and personality were differently related to various

mental health symptoms (Schroder et al., 2015). Similarly, beliefs about self-control malleability could specifically predict some of these behavioural outcomes independently of other types of malleability beliefs. After all, self-control has been associated with academic achievement (see Duckworth et al., 2019), and many mental health issues or problem behaviours can be understood as self-control challenges (e.g., addictions; see Kennett, 2013).

5.3. What Counts as Self-Control? Measurement Challenges

As reported in Chapter 2, limitedness beliefs were moderately correlated with weaker self-rated trait self-control. Previous studies have also reported negative, although somewhat weaker, correlations (de Ridder et al., 2020; Job et al., 2015). By contrast, no significant correlation was found between malleability beliefs and trait self-control. The interpretation of these findings depends on what we think that the Brief Self-Control Scale (Tangney et al., 2004) is measuring. If we understand this scale primarily as a measure of people's *subjective views* of their own self-control capacity, the null-to-moderate correlations simply demonstrate an empirical distinction between such views and the beliefs about the nature of self-control. However, self-reported trait self-control is associated with important real-life outcomes from educational achievement to health behaviours (see de Ridder et al., 2012; Hagger & Hamilton, 2024) and has been used as an estimate of people's self-control capacity. From this perspective, the correlation between limitedness beliefs subscales and the Brief Self-Control Scale supports the predictive validity of the limitedness subscales. By contrast, the lack of such correlation in the case of the fixedness subscale raises questions about the validity of this subscale. That said, more research should be conducted before making firm conclusions on the value of malleability beliefs in predicting self-control behaviour – especially considering

that different self-control measures are not strongly correlated with each other (Duckworth & Kern, 2011; Eisenberg et al., 2019; Saunders et al., 2018).

Even the association between limitedness beliefs and self-control performance appears to depend on contextual factors. Studies reported in Chapter 4 did not find any significant association between working memory performance and mental-effort limitedness beliefs. Earlier studies have found that less limited beliefs are associated with both real-life self-control success and better performance in controlled EF tasks, including working memory tasks (e.g., Job et al., 2010; Miller et al., 2012; see Francis & Job, 2018) – particularly when people are faced with extended self-regulatory demands. However, the present results underline the fact that this association may be relatively task-specific. For example, the effect of limitedness beliefs might depend on the type of cognitive demand. Some previous studies have found that the effect of nonlimited beliefs depends on task characteristics and can even be negative in some contexts (Toyama et al., 2022; Vohs et al., 2012). If a person knows that they will face multiple tasks requiring effortful self-control, viewing self-control as a limited resource may keep them from exhausting themselves during the first task and allow them to complete the latter tasks more successfully.

Moreover, Chapter 3 does not suggest any consistent association between self-control strategies and either limitedness or fixedness beliefs. I expected that the knowledge and frequent use of situational self-control strategies would be associated with a less limited and more malleable view of self-control. However, even people who know and use situational strategies may not consider such strategies as prototypical examples of self-control or willpower. Some existing research suggests that while people might recognise situational strategies as instances self-control, they still tend to see effortful intrapsychic strategies as more indicative of self-control (Bermudéz et al., 2023; Gennara

et al., 2023). In other words, people may see situational strategies more as “compensatory strategies” than prototypical self-control.

Hence, lay understandings of self-control may diverge from the functionalist models of self-control (e.g., Duckworth et al., 2016; Hofmann, 2024; Koi, 2021). This does not disqualify the empirical findings on the importance of situational strategies and environmental factors in successful self-control, but it complicates research with self-report measures. If researchers and study participants have different conceptions of self-control, this must be considered when designing studies and interpreting their results.

5.4. Whose Self-Control? Metacognitive Beliefs and ADHD

Perhaps the most important contribution of the present dissertation is the finding that people hold different views about the short-term limitedness and long-term malleability of self-control depending on the characteristics of the person whose self-control they are thinking about. In particular, the results reported in Chapter 3 suggest a link between self-control beliefs and ADHD. If people know that another person has ADHD, they are more likely to assume that this person’s self-control is a limited resource and a fixed trait. The effect was even stronger for people who themselves had ADHD. Our explorative analyses further suggested that the ADHD group also endorsed more limited and fixed beliefs about their own self-control than the non-ADHD group. Thus, people associate ADHD with a more limited and fixed self-control, whether they are thinking about another person or themselves.

ADHD is a well-known diagnosis, and its key features – attention difficulties, hyperactivity, and impulsivity – are often seen as limitations of self-control (see Eme, 2016; Koi, 2021). However, it appears that people expect that the effects of ADHD go beyond an individual’s baseline self-control ability. ADHD is seen as something that can affect the very nature of self-control: whether a person’s self-control is a limited resource and

whether they can change their self-control abilities in the long term. In this sense, people view ADHD as a limit to personal agency.

An important question is whether and how this difference in metacognitive beliefs affects behaviour and real-life outcomes. As previous studies have associated limitedness beliefs with weaker self-control performance (Francis & Job, 2018), limitedness beliefs may create additional self-control challenges to people with ADHD. Strong ADHD traits limit people's ability to use intrapsychic self-control strategies that rely directly on effortful EF. A limited and fixed view of self-control may further hamper self-control performance in demanding situations and create self-fulfilling prophecies. Indeed, explorative analyses suggested that the ADHD group had poorer subjective well-being than the non-ADHD group and that this difference was partly explained by differences in limitedness beliefs. Previous studies have similarly reported negative associations between limitedness beliefs and well-being, and suggested that the link is partly mediated by goal striving, such that limitedness beliefs are related to less successful goal striving, which in turn predicts poorer well-being (Bernecker et al., 2017).

However, as noted above, viewing self-control as limited may sometimes be adaptive (Toyama et al., 2022). Arguably, since attentional control is more difficult to people with strong ADHD traits, viewing one's self-control as a limited resource might be both realistic and adaptive for them in contexts where no situational strategies are available. Secondly, to my knowledge, no studies so far have examined how people's beliefs about another person's self-control affect their attitudes and behaviour towards this person – for example, the advice given during self-control challenges or judgments about responsibility (see Koi, 2021). These things may partly depend on what people count as self-control and whether they are familiar with situational self-control strategies. Even if two people both think that a person with ADHD has a very limited and fixed self-control

capacity, they may have different views on whether there are effective compensatory strategies. This, in turn, may affect their attitudes and behaviour towards a person with ADHD.

Contrary to our hypothesis, people with ADHD did not view situational self-control strategies as more effective or less demanding than intrapsychic strategies. In fact, the ADHD group rated situational strategies slightly less effective than intrapsychic strategies. Moreover, use of situational strategies was not associated with better subjective well-being. As noted in Chapter 3, these results must be interpreted with caution as only self-report measures were used. Future research should investigate the topic with more objective measures of self-control performance, such as task-based measures and real-life outcomes (e.g., health behaviour or academic success). Furthermore, simply assessing the overall use of situational strategies may not be an optimal measure of successful self-control – even in people with strong ADHD traits. Instead, it might be necessary to investigate *how* people with and without ADHD use situational and intrapsychic strategies in different contexts.

Nevertheless, our preliminary findings suggest that, even if self-control beliefs are associated with goal striving and well-being, this link may not result from differences in self-control strategies. Instead, the effect of self-control beliefs could rely on other mechanisms. For example, it has been suggested that self-control beliefs could affect self-control performance by guiding how people interpret their mental fatigue (Francis & Job, 2018; Job et al., 2010; see also Clarkson et al., 2016). A less limited view of self-control might encourage people to persist on a challenging task despite initial signs of fatigue.

5.5 Ambiguous Associations and Parallel Developments: Self-Control and EF

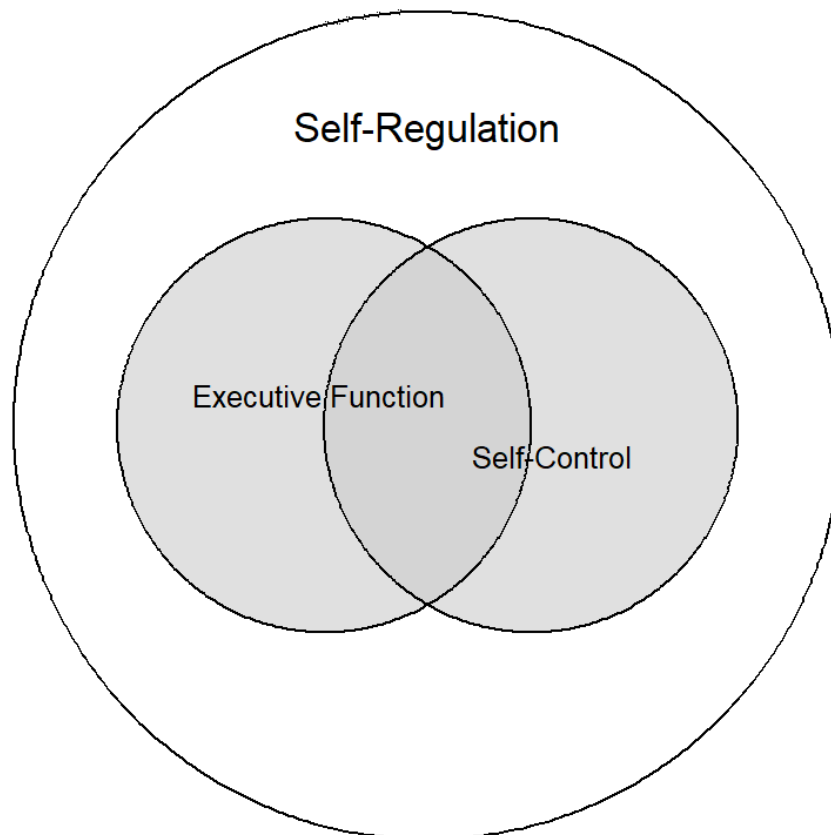
Research literature on self-control and related phenomena shows clear signs of the so-called jingle-jangle fallacy (see Milyavskaya, 2019). Very different measures, based on

fundamentally distinct conceptualisations of self-control, are regardless assumed to measure the same thing (e.g., questionnaires on everyday self-control success vs. controlled EF tasks; jingle fallacy). At the same time, a variety of terms – such as self-control, self-regulation, EF, cognitive control, or inhibition – have been used to define what a single task measures (e.g., the Stroop task; jangle fallacy). In this dissertation, I rely on a theoretical framework in which self-regulation describes a broad group of processes that involve goal-directed monitoring and modulating one's thoughts, emotions, and behaviour; whereas self-control refers to specific instances of self-regulation which involve a motivational conflict (Fujita et al., 2025; Milyavskaya et al., 2019). EF or cognitive control, in turn, describes the top-down control mechanisms that modulate various cognitive subprocesses to enable goal-directed behaviour (Diamond, 2013; Miyake & Friedman, 2012; Zelazo, 2015).

In sum, self-regulation can be understood as the broadest term, describing any processes that regulate one's own thoughts, emotions, and behaviour. The other terms are basically subclasses of self-regulation: EF and cognitive control refer to cognitive self-regulation processes, and self-control encompasses self-regulation processes that deal with motivational conflicts (Figure 1). Finally, inhibition is often studied as a subcomponent of EF. However, as noted in Chapter 3, inhibition has been defined and operationalised in various ways, and the dilution and overextension of the construct have arguably undermined this line of research (Werner et al., 2022). Indeed, it might be more accurate to understand inhibition as an outcome rather than a specific process.

Figure 1

Conceptual Framework of Self-Regulation



Accumulating empirical evidence suggests that real-life self-control success cannot be reduced to effortful EF (see Hoffman, 2024). In everyday self-control, EF works in constant interaction with situational factors and people's personal motives. Yet, intrapsychic cognitive processes still play a crucial role in the equation. Even situational self-control strategies, which rely on our external environment (e.g., choosing a quiet working place, seeking out social support), will ultimately work only if they successfully shape our attention, cognitive appraisals, and response tendencies (Duckworth et al., 2016). Thus, understanding self-control also requires research on EF.

To this end, Chapter 4 examined strategy use and metacognition in the context of working memory, a key component of EF (Baddeley, 2012; Diamond, 2013; Miyake & Friedman, 2012). The primary aim of the two studies reported in this chapter was to test a

hypothesis on the role of language in information processing. Many studies have reported that inner speech and verbal representations can support the short-term maintenance of goal-relevant information (see Alderson-Day & Fernyhough, 2015; Baddeley, 2012). The present studies complement this picture by providing preliminary evidence that inner speech can also support the efficient updating of the relevant information. This is in line with theories suggesting that verbal representations provide a more general processing advantage (Kompa & Mueller, 2020; Lupyan & Swingley, 2012). Researchers have suggested that this advantage comes from the relatively abstract nature of language: omitting concrete, context-specific details may reduce cognitive load and boost processing efficiency.

As noted in Chapter 1, there are some interesting similarities between this line of research and a recent theory about self-control that defines self-control challenges as regulatory scope problems (Fujita et al., 2025). This theory argues that successful self-control requires the capacity to address relatively expansive considerations such as long-term health consequences or social commitments by overriding more contractive “here-and-now” concerns. Cognitive abstraction has been highlighted as a crucial skill for modulating regulatory scope: recognising single events and decisions as instances of a broader category or behavioural pattern allows us to expand our regulatory scope. Again, language provides a useful tool for such abstraction (e.g., Carnevale et al., 2015; see Trope et al., 2021). If future studies further support these hypotheses of “abstraction advantage”, this perspective may be relevant for several research domains within cognitive psychology. For example, developmental research could investigate the role of inner speech and verbal representations in the development of EF and self-control.

5.6 Conclusion

In this dissertation, I have examined self-control, metacognition, strategies, EF, and their interactions. My findings suggest that self-control beliefs are multidimensional and domain-specific. A more comprehensive model of lay beliefs about self-control can allow us to better understand metacognitive mechanisms underlying everyday self-control. This dissertation also opens new avenues for future research by demonstrating that people's beliefs about self-control depend on the characteristics of the person whose self-control they are thinking about. In particular, people associate ADHD with a more limited and fixed self-control, whether they are thinking about another person or themselves. Furthermore, I provide preliminary evidence that such differences in self-control beliefs may partially explain the negative association between ADHD and subjective well-being. Collectively, these findings suggest that, in addition to challenges related directly to attentional control, people with ADHD may also face additional disadvantages caused by self-reinforcing beliefs about their self-control. Finally, my research offers preliminary support for the hypothesis that the abstract code provided by language provides a general processing advantage that benefits EF. I hope that the theoretical and practical implications of these findings will guide future research. Eventually, this work can help us to better support individuals' self-control in different contexts by fostering adaptive beliefs and pointing out useful strategies.

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