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Review article

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Mutual implications of procrastination research in adults and children for theory and intervention

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Abstract

Procrastination is a prevalent form of self-regulatory failure familiar to most people. Although many consider procrastination innocuous as long as the deadline is met, it is associated with negative consequences in various life domains. Thus, it is important to understand why people procrastinate, what factors contribute to procrastination and what can be done to reduce procrastination. Most research on these topics has been conducted with adults, and the few developmental studies have been conducted independently from adult procrastination research. In this Review, we seek to bring these disparate lines of research into closer alignment and point out their mutual implications. Specifically, we discuss how studying procrastination developmentally highlights a need to reconsider a highly restrictive definition of procrastination dominant in adult research. We also suggest future directions for both adult and developmental research, including measurement, theoretical development and interventions.

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Introduction

Procrastination is a prevalent behaviour all too familiar to many: people regularly delay an aversive task (such as working on a tax return or scheduling a colonoscopy) and think "I'll do it later". Many students struggle with academic procrastination. In a 2022 large-scale survey of over 50,000 college students[1], 75% admitted to procrastinating regularly, and about half reported that it had hurt their academic performance in the past year, far more than any other causes of academic difficulties. Procrastination is also prevalent in work settings[2,3]. Employees spend 1.5–3.0 h per day on non-work-related, personal activities[4]. Perhaps because procrastination is so prevalent, many people consider it innocuous and condone it as long as deadlines are met.

However, procrastination is associated with wide-ranging negative life outcomes (Table 1). Although there is some evidence of domain specificity[5], individuals who procrastinate in one domain (for example, in academic settings) also tend to procrastinate in other domains (for example, personal relationships and health)[6]. For example, a 2023 study of over 3,500 university students found that higher self-reported levels of general procrastination at baseline predicted greater psychological distress (for example, depression, anxiety and stress), loneliness, poorer sleep quality, physical inactivity and financial difficulties 9 months later, even after controlling for outcome variables and potential covariates (age, gender, parental education and previous psychiatric diagnoses) assessed at baseline[7]. Procrastinators therefore probably experience many of the negative consequences of procrastination over the course of their lives[8].

Table 1 | Potential negative consequences of procrastination

Domain	Category	Associations with greater procrastination
Academic and work-related consequences	Problems at school	Lower course grades[14] Higher dropout rates[165,166] Higher rates of engaging in academic misconduct (for example, cheating, plagiarism or lying to get deadlines extended)[167,168]
	Problems at work	Lower salary[169] Lower-quality job[169] Shorter employment[169] Lower trust from colleagues[10] Being viewed as a less effective leader[170] Boredom and lack of engagement at work[171,172] Lower job satisfaction[8,169]
Daily-life consequences	Financial problems	More debt[7] Greater difficulty in personal finance management[7,173]
	Personal relationship problems	Higher divorce rates[174] Relationship conflict and poorer family relationships[175]
	Everyday problems	Messy or cluttered homes[176,177] Failing to make appointments[178–181]
Health consequences	Mental health problems	Higher stress levels[7,115] Lower psychological well-being[7,115] Higher internalizing psychopathology (for example, depression and anxiety)[78] Loneliness[7]
	Physical health problems	More sleep problems (due to bedtime procrastination)[7,182] Lower levels of physical activity and fitness[7] Poorer dental health[181,183] More physical pain in the neck, back and extremities[7]

In light of such wide-ranging negative outcomes, procrastination is an important behaviour to study. Although the vast majority of procrastination research has been conducted with young adults, in the past 5 years, there has been an increase in the number of studies examining procrastination as manifested in children as young as 3 years old. However, these two lines of research have so far proceeded independently. A broad developmental perspective on procrastination research might provide fresh insights into fundamental questions, such as why people procrastinate, what factors contribute to procrastination and what can be done to reduce procrastination.

In this Review, we bring together procrastination research in adults and children and explore their mutual implications. We begin with an overview of the adult procrastination literature. We next review the current state of the developmental literature, emphasizing the similarities and differences between procrastination in children and adults. We then discuss how adult and developmental research can mutually benefit each other in terms of conceptualization and measurement, theories, and interventions for procrastination. We conclude by considering future directions for developmental and adult procrastination research.

Procrastination in adults

In this section, we review the current state of adult procrastination research, focusing on the ideas and findings that motivate our later discussion of the developmental literature, mutual implications, and future research directions.

Definitions and measurement

According to the currently dominant conceptualization, an individual's decision to not undertake an intended task must meet additional criteria besides the most obvious one — a delay — to count as an instance of procrastination[6]. Specifically, many researchers studying adult procrastination embrace a multicomponent definition, according to which procrastination must meet all of the following criteria[9]: the start or completion of a task is delayed; the individual has an intention to complete that task; the delay decision is voluntary; the delay is unnecessary; and there is an expectation of future negative consequences (Fig. 1, case 1). This definition suggests that procrastination is maladaptive and even irrational because it involves voluntarily and unnecessarily postponing an intended task despite expecting to be worse off for that delay.

Importantly, according to this multicomponent definition, procrastination must be strictly differentiated from other forms of delay[9–12]. For example, if an individual postpones a task because they believe that doing so will have potential benefits (for example, expecting to receive helpful information later), then it is not procrastination because the anticipation of future negative consequences criterion is not met. Moreover, this definition emphasizes an individual's awareness of the intentionality of putting off an intended task and its potential negative consequences. In fact, only the first criterion — a delay — reflects actual observable behaviours, whereas the rest reflect thought processes that are accessible only to that individual.

Although this multicomponent definition may seem sensible, one major limitation is that it is so restrictive and so dependent on subjective criteria that it might exclude some cases of behavioural delay that

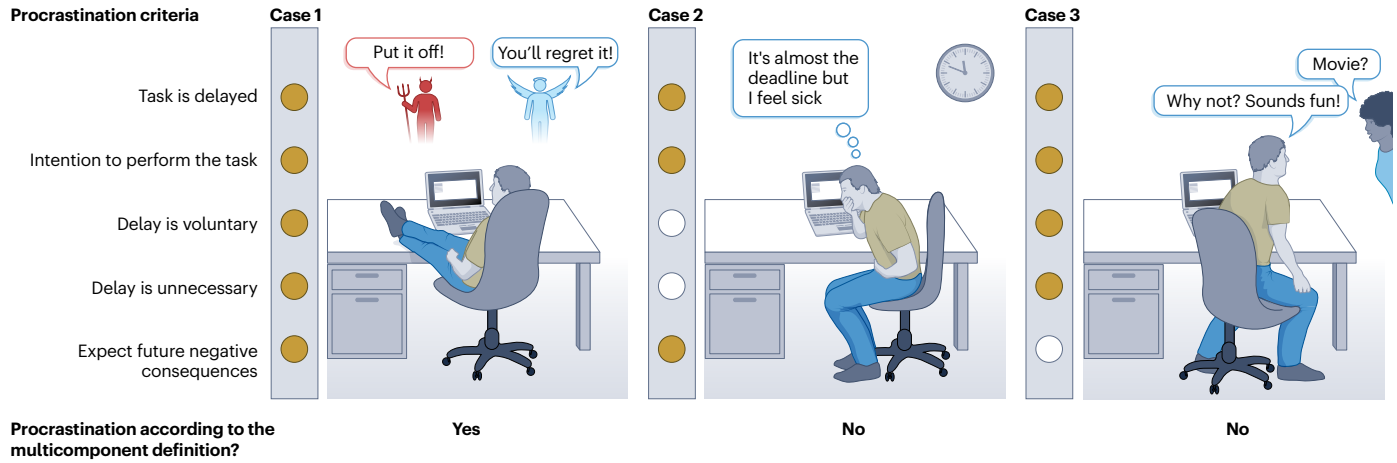

Fig. 1 | Multicomponent definition of procrastination. According to the multicomponent definition of procrastination, procrastination occurs when all the following criteria are met: the start or completion of a task is delayed; there is an intention to complete that task; the delay decision is voluntary; the delay is unnecessary; and there is an expectation of future negative consequences (case 1). According to this restrictive view of procrastination, delaying an intended task because of unexpected challenges (case 2) or impulsive behaviour (case 3) do not constitute procrastination because they do not meet all multicomponent definition criteria.

many would consider as qualifying as procrastination. For example, if a student asks for an extension the night before an assignment deadline owing to a sudden illness but believes that this unexpected delay is involuntary and necessary, it would not qualify as procrastination (Fig. 1, case 2), even if the student has left the assignment to the last minute. Similarly, if an individual postpones a task because they have acted impulsively (for example, saying "yes" right away to a friend's invitation to go see a movie), it also would not qualify as procrastination because there was no explicit consideration of future negative consequence (Fig. 1, case 3).

Probably reflecting the multicomponent definition's emphasis on conscious awareness and intentionality, procrastination is usually measured via self-report questionnaires. However, because it is challenging to probe a person's thought processes at the exact moment at which they decide to postpone an action, procrastination assessment typically targets trait-level individual differences in procrastination tendencies. That is, individuals are asked to rate general statements such as "I often find myself performing tasks that I had intended to do days before" and "In preparing for some deadlines, I often waste time by doing other things"[13].

Despite its popularity, the self-report assessment of procrastination has some major limitations[14,15]. First, people's reports of their mental processes are often inaccurate, partly because they are often unaware of other sources of influence (for example, environmental factors and well-established habits) on their thoughts and behaviour[16,17], and thereby overestimate the intentionality of their actions[18]. Second, existing questionnaires assess how frequently an individual engages in behavioural or decisional delays without systematic consideration of the subjective criteria specified in the multicomponent definition. For example, according to one analysis, only 2 of the 175 items across 18 procrastination scales reflect any consideration of future negative consequences[19]. Even a questionnaire that some researchers[20] argue effectively measures the irrational nature of procrastination includes the item "I procrastinate"[21], which hinges on an individual's intuitive understanding of what procrastination means.

There have also been attempts to assess procrastination using more objective, behavioural indices (Box 1). Despite their promise, such attempts have been met with resistance[19,22] because, again, the multicomponent definition requires insight into intentions and conscious awareness of the negative consequences, which objective measures cannot directly capture.

In summary, although the multicomponent definition of procrastination has been broadly accepted, this strict definition severely (and perhaps unnecessarily) restricts the scope of what procrastination is and is misaligned with current measurement practices. These conceptualization and measurement challenges are even more salient when considering the developmental emergence of procrastination among children.

Correlates of procrastination

Extensive research based on self-report questionnaires has identified major correlates of procrastination in terms of both its potential consequences (Table 1) as well as antecedents.

In terms of antecedents, the two strongest personality correlates are conscientiousness[6,23] and impulsivity[6,24] (and its close associate, trait self-control[25,26]). Individuals who are more conscientious (that is, individuals who make choices deliberately and take obligations seriously) tend to procrastinate less, whereas individuals who are more impulsive and have weaker self-control tend to procrastinate more. Facets of perfectionism related to unrealistic expectations and self-criticism are also positively associated with procrastination tendencies[27,28].

Affective correlates of procrastination have also been identified. A systematic review[29] found that anxiety and fear of failure are the two most frequently studied affective correlates. Whereas fear of failure is usually viewed as an antecedent for procrastination tendencies, anxiety can serve both as an antecedent and a consequence, potentially contributing to a vicious cycle: the thought of working on a task causes anxiety but putting the task off exacerbates anxiety, making it even more difficult to return to the task.

Box 1 | Objective behavioural indices

There has been a rapid increase in research exploring alternative ways of assessing procrastination using objective measures over the past decade. This surge of interest is motivated in part by the wide availability of learning management systems in educational settings, which enable researchers to derive objective indices of the procrastination-related behaviours of students.

The most widely used index — perhaps because it is readily applicable to many courses — is assignment submission times and their variants[194–196]. Submission times index how early assignments were submitted relative to the deadline. For example, students who regularly submitted assignments early earned better final course grades and reported less stress than those who regularly submitted assignments right before the deadlines, even when known correlates (such as conscientiousness) were controlled for (A.M., unpublished work). Moreover, this predictive power was observed when the analysis was restricted to submission times from only the first 3 weeks of classes, suggesting that behavioural measures can be used for early identification of at-risk students for personalized guidance and intervention. Importantly, submission times were correlated with end-of-semester self-reports of procrastination specific to course assignments. Moreover, although the objective and self-report measures both predicted final grades, their predictive powers stemmed mainly from the variance shared between the two, pointing to the possibility that objective indices such as submission times could substitute for self-reports in some cases.

A comparison of learning management systems activities on normal course days versus on due dates can provide another objective, fine-grained index of the procrastination behaviours of students. For example, students who regularly procrastinate tend to have a disproportionate number of clicks on due dates relative to other class days[197]. Another technique involves the use of a clustering algorithm to identify subgroups of students with different learning management system-usage profiles[198,199]. For example, a study conducted in a large chemistry class[197] found that students who engaged with the learning management system early and often (early planners) had higher course grades than students who used the learning management system infrequently (low-engagement users) or near deadlines only (procrastinators).

Objective behavioural indices do not indicate why students completed assignments when they did (for example, whether they planned in advance or were delayed by unexpected disruptions). As such, they are not pure measures that satisfy all multicomponent definition criteria. Nevertheless, objective measures are critically important for future procrastination research because they are not susceptible to inaccurate or dishonest reporting[14], including post-hoc rationalization. Moreover, objective indices are necessary for rigorous intervention studies: effective interventions should change actual behaviours not just subjective feelings[140]. Future research should further explore objective indices (both in and out of educational settings) and systematically examine relationships between objective and subjective (self-report) measures.

There has been relatively less research on the cognitive correlates of procrastination. However, procrastination has been shown to be associated with two cognitive constructs: executive functions[30–32] (control processes associated with the regulation of thought and action) and prospective memory[24,33,34] (memory for future intentions). The former contributes to goal management and self-control (for example, overriding unwanted or entrenched behaviours), whereas the latter is critical for remembering to work on a task at an appropriate time.

In addition to these correlates based on individual differences, environmental factors have also been associated with procrastination tendencies. For example, distracting environments full of temptations (such as electronic devices) can steer individuals — especially impulsive ones — away from their intended task at school[35] or work[36]. Work environments that promote aversive feelings and reduce engagement (such as time pressure[37], abusive supervision[38] and poor management[3]) have also been associated with workplace procrastination. Moreover, university environments have been characterized as 'procrastination friendly'[39] because various factors known to increase the likelihood of procrastination (such as temptations and distractions, long deadlines, and lack of study skills training) are prevalent[40].

The identification of these key correlates has provided a basis for exploring the biological (genetic and neural) bases of procrastination (Box 2). Moreover, some contributing factors (such as impulsivity, task aversion and negative affect) have prominent roles in theoretical models of procrastination.

Main theoretical frameworks

Two main classes of models have been proposed to shed light on why people procrastinate: utility models similar to those used to investigate the rationality of decision-making[41] and process models of self-regulation that focus on emotion and motivation. Both types of models view procrastination as a self-regulatory failure resulting in a gap between intention and action.

Utility models seek to specify the change over time in the likelihood that an individual starts to perform a task[6,11,42–44]. The best-known model in this category is temporal motivation theory[6,11,45], also known as the 'procrastination equation'. According to this theory, an individual will not start working on an intended task until its utility (personal importance) — or the motivation level for starting to perform the task — reaches a certain threshold (Fig. 2a). A task's utility is influenced by multiple factors, which positively or negatively influence the start (and completion) time of the intended task. Higher confidence in one's ability to achieve an outcome (expectancy) as well as higher perceived worth for that outcome (value) increase utility and make people less likely to procrastinate. Even if the outcome is achievable and valuable, people might still put off the task if the deadline is not imminent (delay) or if they tend to act without deliberation (impulsivity). Some variants of this model incorporate additional components such as task aversiveness[42,46]. Related computational modelling work elaborates on the roles of value (versus effort required)[43,44,47].

By contrast, process models of self-regulation seek to mechanistically specify the processes underlying decisions to put off a to-be-completed task[48,49]. The best-known model in this category

is short-term mood repair theory[10,49], according to which procrastination is an emotion regulation problem. Similar to an earlier proposal that characterized procrastination as a mechanism for coping with the anxiety associated with starting or completing a task[50], short-term mood repair theory portrays procrastination as the outcome of a coping strategy for dealing with negative affect. Specifically, thinking about having to perform an aversive task gives rise to a negative mood (for example, boredom, dread or anxiety), which in turn leads an individual to seek temporary relief from that negative mood (Fig. 2b, top panel). This 'mood repair' often takes the form of seeking immediately more pleasurable activities (for example, checking social media) and creates a conflict between short-term pleasure and a more meaningful long-term goal. This conflict often gets resolved in favour of the former, resulting in procrastination. Although the word 'repair' implies actively seeking an alternative, simply avoiding an aversive task might also temporarily alleviate negative mood.

In summary, temporal motivation theory and short-term mood repair theory jointly shed light on why procrastination is prevalent and why it is difficult to overcome. Not all tasks have high value or are fun, and the aversive feeling associated with some tasks could be difficult to overcome, especially when the deadline is distant or absent. Negative feelings might be especially challenging to overcome for individuals who tend to experience stronger negative emotional reactions (for example, individuals with depression and anxiety or highly self-critical individuals). Moreover, daily environments include many distractions and temptations that provide quick and easy sources of short-term pleasure (such as smartphones), making some individuals even more prone to procrastination (for example, impulsive individuals or those who have developed a strong smartphone habit).

Interventions

Many popular books provide suggestions for how to reduce procrastination[10–12,50–54]. Although many of the tips offered in these books are consistent with existing correlational evidence, they are not supported by experimental evidence that causally establishes the effectiveness of these techniques for objectively reducing procrastination behaviours. Moreover, the number of procrastination intervention studies is surprisingly small: three meta-analytic reviews[55–57] published in 2018 and 2019 each identified only 12–35 studies that met their respective inclusion criteria; a 2023 systematic review[58] identified 21 additional studies published since these meta-analyses.

Box 2 | The biological basis of procrastination

Research has provided insights into the genetic and neural underpinnings of procrastination.

Genetic basis

A behavioural genetic study[24] of adult monozygotic (identical) and dizygotic (fraternal) twins found that individual differences in procrastination tendencies and impulsivity (both assessed with questionnaires) were each moderately heritable (~50%), and the rest of the variance was attributable to non-shared environmental factors (that is, unique to each twin). As expected, trait-level procrastination tendencies and impulsivity were substantially correlated with each other but the overlap between them was attributable entirely to genetic (rather than environmental) influences. Moreover, this shared genetic variation between procrastination and impulsivity further overlapped substantially with individual differences in goal failures (for example, forgetting to complete an intended action later), suggesting a substantial connection with prospective memory and goal management. A subsequent study demonstrated that the association between procrastination and executive functions substantially reflected genetic influences[30].

Such genetic-level connections between procrastination, impulsivity and goal management are consistent with the proposal that procrastination might have evolved as an adaptive trait[11,24]. Impulsively seeking an immediate reward over a long-term goal might have been desirable (even necessary) for Plio-Pleistocene hunter-gatherers because the future availability of food and other essential resources for survival was uncertain. In other words, acting immediately was a virtue back then. By contrast, acting immediately is less adaptive in modern society because of the relative stability of the environment and the benefits that come with long-term planning.

Importantly, the presence of moderate genetic influences on procrastination tendencies does not imply the immutability of procrastination within an individual. Instead, it suggests that variations in trait-level procrastination across individuals reflect some genetic influences, making some individuals (especially impulsive ones) more predisposed toward — and therefore more susceptible to — procrastination than other individuals.

Neural basis

Because it is difficult to induce procrastination in laboratory settings, the existing electrophysiological[200,201] and neuroimaging[46,202] research primarily examined differences in brain activity between individuals high versus low in trait-level procrastination (assessed by questionnaires). For example, one study found that, compared to low-procrastination individuals, high-procrastination individuals engaged in less proactive control (that is, they engaged in less advance preparation for forthcoming stimuli) and allocated less attention to task-relevant stimuli as indexed by the event-related potential components known as contingent negative variation and P3b, respectively[201].

Neuroimaging studies generally point to the parahippocampal gyrus (part of the limbic system) and the ventromedial and lateral prefrontal cortex as two key neural substrates underlying trait procrastination or procrastination-related decision-making[203,204]. Although the functions of these regions are multifaceted, the parahippocampal gyrus is often linked to episodic future thinking and emotional memories, whereas the prefrontal cortex is often linked to emotion regulation (ventromedial prefrontal cortex) and goal maintenance and executive functions (lateral prefrontal cortex)[46].

Currently, it is not clear how those processes examined in electrophysiological studies or different brain regions identified in neuroimaging research interact in real time and contribute to an individual's decision to work on or put off a task in everyday settings. Nevertheless, these neuroscience findings are likely to contribute substantially to future theoretical development.

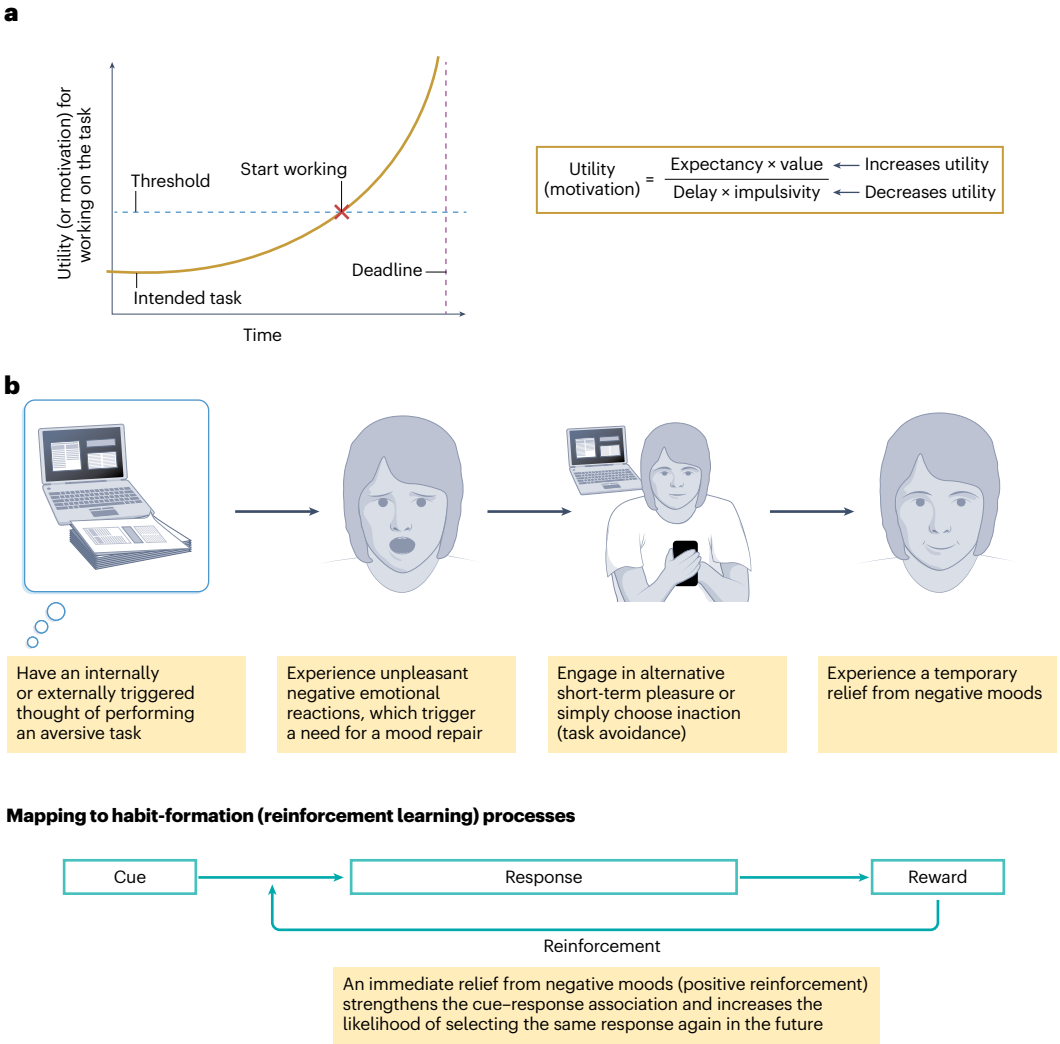

Fig. 2 | Prominent theories of procrastination. a, According to temporal motivation theory, an individual will not start working on a task until its utility or their motivation level reaches a certain threshold. As indicated by the 'procrastination equation' on the right, confidence in one's ability to achieve an outcome (expectancy) and perceived worth of that outcome (value) increase utility; time until the deadline (delay) and impulsiveness decrease utility. **b**, According to short-term mood repair theory, thinking about having to perform an aversive task gives rise to a negative mood, which leads an individual to seek temporary relief from that negative mood. This 'mood repair' often takes the form of seeking immediately more pleasurable activities (for example, checking social media) and creates a conflict between short-term pleasure and a more meaningful long-term goal. This conflict often gets resolved in favour of the former, resulting in procrastination. This sequence of events can be mapped onto the reinforcement learning process (cues, responses and rewards; green boxes), thereby providing a theoretical starting point for linking the procrastination and habit literatures.

Importantly, all three meta-analyses reported a significant effect of interventions, although effect-size estimates varied, ranging from a small effect ($g = 0.34$)[56] to a medium effect ($g = 0.62$)[55] to a large effect ($g = 1.18$)[57]. The meta-analysed studies used different types of interventions, and therapy-based approaches (especially cognitive behavioural therapy) yielded the largest effect sizes[55,56]. The effectiveness of therapy-based interventions that target changing the interpretation and regulation of negative moods is consistent with the emphasis on task aversion and negative moods in short-term mood repair theory[10,49].

However, existing intervention studies are limited in several ways. First, they suffer from various methodological weaknesses (for example, small sample sizes, no active control group, insufficient protection against bias risk and/or no preregistration)[58]. Second, two reviews[55,58] found some evidence of publication bias, pointing to a potential file-drawer problem in this literature, such that intervention studies that do not yield significant effects are not published. Third, even when studies assessed the effect of interventions at a follow-up 1 week to 6 months later (many did not[55–58]), the overall effect was not significant in one meta-analysis ($g = -0.01$, $p = 0.79$)[55], suggesting that initially effective interventions do not necessarily turn into long-lasting procrastination-reducing habits. Finally, existing intervention research has given little attention to proactively preventing the future emergence of procrastination, which is important to consider when examining children's procrastination.

Procrastination in children

In contrast to the wealth of research on adults, relatively few studies have investigated procrastination during childhood. Procrastination in young children has been assessed differently from procrastination in adults, using simplified self-reports, parent reports and behavioural tasks[59–62] (Box 3). Here, we review this limited but growing literature. Specifically, we characterize developmental changes in the targets and contexts of procrastination and review the correlates and other developing abilities that might contribute to the emergence of procrastination in children.

Targets and contexts of procrastination

Most studies on children have examined procrastination in different age groups of children without attention to how procrastination changes within individuals with age, limiting what is known about how procrastination develops across childhood. This literature nonetheless suggests that procrastination tendencies emerge early and that the targets and contexts of procrastination differ across development (Fig. 3).

Parents of preschool-aged children report that younger preschoolers (age 3–4) procrastinate in cleaning up messes and engaging in household routines (for example, putting away toys or brushing teeth before going to bed). By contrast, older preschoolers (age 5–6) more often procrastinate doing chores and completing homework[60].

The targets of procrastination shift as children become more self-directed in their daily activities. Parents often direct young children when to perform tasks and follow up with reminders when they fail to follow through. However, as children get older, they begin carrying out their intentions more independently without explicit cueing or scaffolding from adults[63]. As children transition to elementary school, academic assignments and homework become the primary targets of procrastination[62,64,65].

During adolescence, academic tasks become more challenging alongside an uptick in extracurricular activities, part-time jobs, and peer and romantic relationships. Adolescents also juggle multiple goals (for example, related to school, a job and relationships) compared to children who might have a single goal or at least fewer competing goals[66]. Given the demands from multiple responsibilities and increasing independence in managing their time, it is not surprising that procrastination becomes highly prevalent and problematic during adolescence and emerging adulthood[7,67].

Despite studies documenting that the targets and contexts of procrastination evolve during development, the emerging literature still paints an incomplete picture. For example, it is unknown whether procrastination increases or decreases across early childhood: according to parent reports, children's procrastination tendencies increase over the preschool years (3–6 years of age)[60], yet a study reported in a conference proceeding that used a behavioural task suggests a decrease in procrastination during this same period[59].

Correlates of procrastination

Despite developmental changes in the targets and contexts of procrastination, the correlates of procrastination are similar in childhood and adulthood. As in adults, personality factors, such as conscientiousness[61,68], effortful control (an aspect of temperament related to self-regulation)[61] and perfectionism[69], have been linked to procrastination in children and adolescents. Impulsivity has not been measured in studies of procrastination in children but there is a negative association between emotional control and procrastination in preschoolers[60].

In terms of affective correlates, similar to adults, adolescents procrastinate more on aversive tasks that make them anxious[64]. Higher levels of negative emotions (for example, anxiety and depression) are

Box 3 | Measurement of procrastination in children

Because young children are unable to accurately report on their own behaviour, studies of procrastination in young children have used parent reports and behavioural measures of procrastination. However, each type of assessment used to study procrastination in children fails to meet one or more of the multicomponent definition criteria.

In some studies, adult questionnaires[13] were adapted into parent-report questionnaires[60,61]. In one study[60], parents were additionally asked to provide examples of the last time their child procrastinated. One limitation inherent to such reports is that it is difficult for parents to report on their children's intentions or anticipation of negative consequences and therefore they focus on externally observable behaviours.

Studies with older children have used simplified self-report measures of procrastination. For example, in one study[62], 8–10-year-old children were asked to endorse one of two opposite statements that most clearly described them (for example, "Some kids do their homework as soon as they can" versus "Other kids do their homework at the last minute"). Notably, these items probe general tendencies rather than assessing specific behaviours.

There have also been attempts to develop behavioural tasks to capture procrastination in young children. For example, in one study[59], 3–6-year-olds in daycare were asked whether they wanted to complete a boring bead sorting task now or the next day. They were awarded one token (that could be traded in for gifts) for every 20 yellow beads that they sorted from a large pile. Children who opted to delay the task sorted fewer beads than those who completed the task right away. Moreover, older children delayed the task less often than younger children. However, it is unclear whether children intended to complete the task the next day and whether losing tokens was considered a substantial enough negative consequence to motivate behaviour.

Although the multicomponent definition emphasizes the importance of subjective criteria in capturing procrastination, the reality is that parent-report and behavioural measures are probably the only practical way to measure procrastination and its precursors in early childhood before the ability to reflect and accurately report on intentions emerges. Indeed, in large-scale studies, children's self-control was measured by a combination of self, teacher and parent reports as well as observable behaviour[205,206]. Thus, using multiple informants and a variety of questionnaires and behavioural measures might be the best way to capture procrastination in children. However, it is currently unknown whether there is a relation between parent-report and behavioural measures of procrastination in children. This is an important question for future research.

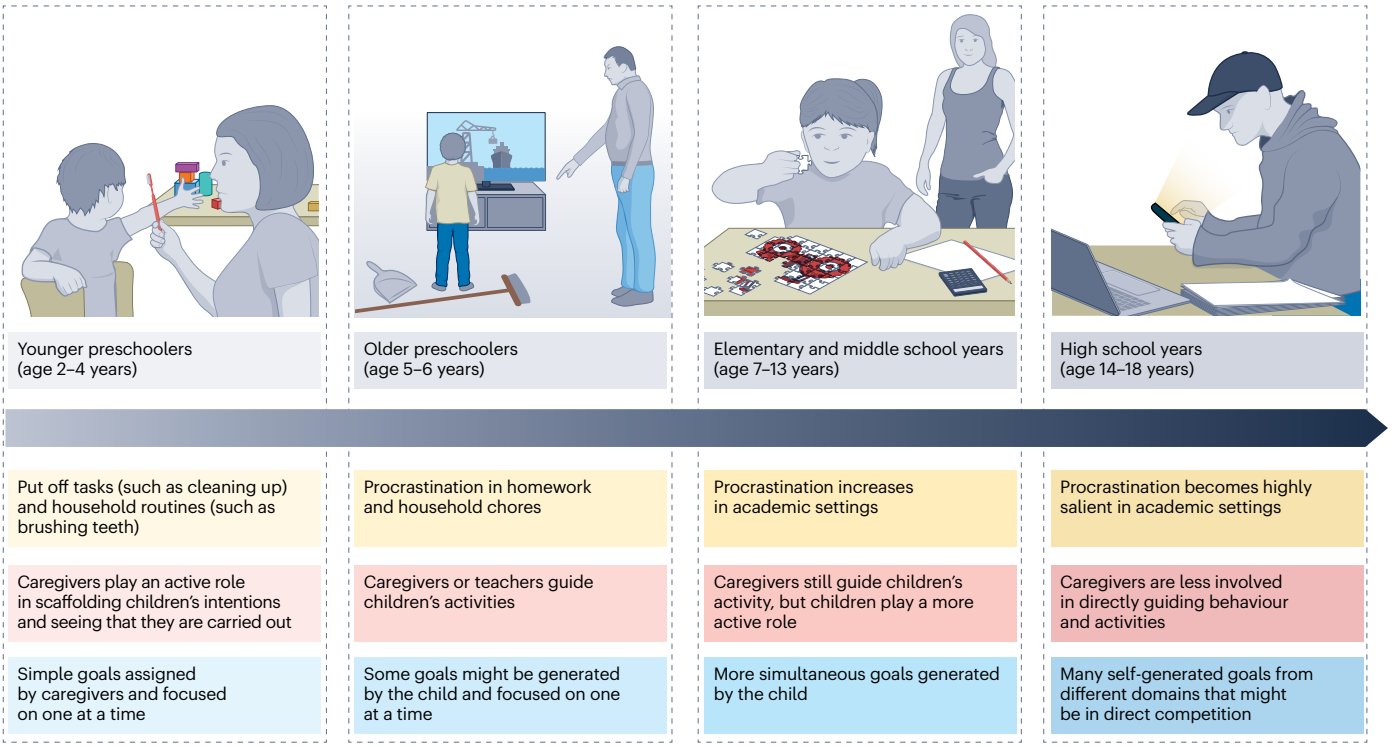

Fig. 3 | Targets and context of procrastination across development. Targets of procrastination change over the course of development. Procrastination becomes more prevalent over development as children become more self-directed in their daily activities and carry out intentions with less explicit cueing or scaffolding from adults, and as the number of simultaneous and competing goals increases.

also associated with more procrastination in adolescents[62,67]. Similarly, parent-reported negative affect was associated with greater procrastination tendencies in preschool children[61].

The evidence for cognitive correlates of procrastination in children is scarce. However, as in the adult literature, executive function and prospective memory have been identified as potential cognitive correlates[60].

As for environmental correlates, procrastination is associated with environments that probably promote negative affect in children. In particular, parenting style has been linked with youth procrastination behaviour. For instance, adolescents whose parental relationships were defined by greater trust and communication, less alienation, and greater autonomy support procrastinated less[70–72]. This relationship is also present early in development: parents of 3–6-year-olds who allowed their children more input into daily activities (democratic participation parenting) report that their children have fewer procrastination tendencies[61]. In a study that compared 12–13-year-olds perceptions of their mother's and teacher's autonomy support, only mothers' support was directly associated with children's academic procrastination[65].

Relevant emerging abilities

Multiple abilities that emerge during development might be necessary for children to effectively curb procrastination (Table 2). However, evidence for their precise roles is scarce. In particular, some emerging abilities might have opposing influences, potentially both promoting and reducing procrastination.

Introspective abilities. Children's ability to reflect on their thoughts, motives and behaviours is critically important for understanding procrastination because self-regulatory processes can be guided by such metacognitive awareness[73]. Children's introspection ability is limited early in development[74]. For instance, 5-year-olds are more likely to report that they had no thoughts for 25 s compared to 8-year-olds and adults, who recognize that they had thoughts even when they tried not to[75]. With age, children become increasingly aware of their thoughts and therefore should become increasingly aware of their intentions (such as the intention to delay a task or to revisit that task later).

The ability to provide accurate self-reports is also relevant to procrastination, especially considering the multicomponent definition's reliance on subjective criteria. Some studies suggest that children do not have these self-report capacities until age 6 or 7 years[76,77] but when children can provide accurate self-reports is largely dependent on the domain and method of query[78]. Children as young as 5 years old can accurately report on their health and health-related quality of life[76,77] but they cannot accurately report on their thoughts and intentions until around age 8 (ref. 75).

Future-oriented cognitive abilities. The ability to represent the future is essential for procrastination: children must be able to represent the future to realize that a task can be delayed to a later point in time. In general, across early childhood, children become better able to project themselves into future episodes, form their own future task goals and engage control processes proactively in anticipation of future needs (rather than only reactively in response to current demands)[79–81].

By 7–8 years of age, children begin to imagine or simulate personal future events (episodic future thinking) without being explicitly cued[82]. Thus, emerging abilities to represent the future not only give rise to procrastination behaviours in children but might also lead to reductions in procrastination as children become capable of imagining what might happen in response to their action or inaction (for example, being scolded for putting off a task).

Episodic future thinking might also promote procrastination if individuals believe that their future selves will have more capacity to carry out tasks than their present selves. Although children can sometimes be pessimistic after negative outcomes[83,84], they are generally over-optimistic about their abilities and performance[85,86], even more so than adults. Children's extreme optimism surrounding their cognitive abilities[87] and optimistic future forecasting[88] might promote procrastination, just like adults who fall prey to these same biases[89].

To execute a plan and avoid procrastinating, children need prospective memory so that they can remember to carry out their intended actions at the appropriate time. Although basic memory abilities that support remembering an intention are in place by around 4 years of age, it is not until 5 or 6 years old that children can reliably remember and carry out their future goals at the appropriate time[90]. Prospective memory might therefore be key in reconsidering prior task goals to complete the postponed task, especially in the absence of direct cueing from adults.

Finally, procrastination might be reduced by formulating a specific plan in advance and selecting a realistic strategy for completing the task (for example, breaking a task down into smaller parts and identifying times to work on each part). Children's planning abilities undergo major improvements during early childhood; 3–4-year-olds can form simple plans with support from adults but it is not until ages 7 and beyond that children can form a plan without external support[82,91].

Executive function and self-regulation abilities. Multiple aspects of executive function develop substantially during childhood[92–94] and could support children in overcoming procrastination. General executive abilities[95,96] reflect the commonality shared across different types of executive functions (such as inhibition, shifting and working memory updating) and have been linked to goal-management abilities (tendencies to retrieve, activate and maintain appropriate task goals[95]); such abilities might be particularly critical to overcoming procrastination, especially considering that adult research has shown links between general executive abilities, procrastination and goal-management abilities[30]. Although such three-way associations

Table 2 | Emerging abilities related to procrastination in children

Emerging ability	Age-related changes	Relation to procrastination
Introspective abilities		
Introspection	Children are increasingly able to reflect on their thinking as they age[75,184]	Children must be able to monitor and reflect on their intentions to be aware of the task that needs to be carried out
	Children become less over-optimistic about their abilities as they get older[85,86]	Overoptimism might encourage procrastination if children are optimistic about their future compared to current abilities
Self-report	In some domains (such as quality of life), children as young as 5 years can provide accurate oral reports[185,186]	Accurate self-report enables the use of questionnaires (oral or written) to measure procrastination
	Children can self-report in writing around 8 or 9 years of age when their reading is sufficiently developed[62]	Self-reports uniquely probe intentions to complete a task, which is difficult to capture behaviourally, and can potentially capture anticipation of negative consequences
Future-oriented cognitive abilities		
Representing the future	Emerges around age 3 years[187] and increases with age	The ability to more accurately consider the future and future selves should reduce procrastination
	Evidence of spontaneous future thinking around 7 years of age[82]	The ability to represent future points in time might give rise to the possibility of procrastination
Prospective memory	2–3-year-olds have trouble remembering their intentions[90,188]	Prospective memory supports children's ability to remember to carry out the task at hand
	By 5–6 years of age, children are more reliable in remembering to carry out their future intentions at the appropriate time[90]	Prospective memory might support remembering to complete a delayed task in the future thereby reducing procrastination
Planning	Planning becomes more flexible and complex across childhood[91]	Forming plans to carry out tasks reduces the likelihood of procrastination
Executive function and self-regulation abilities		
General executive abilities	Gradual increases over development with rapid increases in early childhood and adolescence[189]	Executive functions support keeping intentions in mind, shifting between different tasks and inhibiting present thoughts
Self-control	Increases across early development and childhood[190]	Self-control enables individuals to carefully consider actions that will be beneficial to complete
Delay of gratification	Mixed evidence on whether this ability increases with age[191] or remains stable across development[192,193]	Better delay of gratification should enable children to persist in completing undesirable tasks and avoid engaging in more gratifying alternative tasks
Emotion regulation	Increases across childhood and particularly in adolescence[111,112] as strategies for regulation and coping become more sophisticated	Development of emotion regulation abilities makes strategies other than procrastination available to regulate negative emotions, reducing the need to engage in procrastination as a mood repair coping strategy

have not been demonstrated in children, prior research has shown that procrastination tendencies are associated with executive function in children[60]. Children also have difficulty with goal management. For example, they can exhibit goal neglect, whereby they do not act on their goals despite being able to report them when queried[97–100]. Goal neglect decreases as children get older[101] and their working memory capacity increases[102].

Children also become increasingly proactive in their engagement of executive function[79,80,103,104] and more self-directed[105–107] over the course of development. Proactive control involves engaging control to guide lower-level processes in a preparatory fashion and so could support completing tasks before a deadline. By contrast, reactive control involves engaging control the moment it is needed[108] and so might be more relevant for completing tasks at the last moment. Self-directed executive function is driven endogenously (rather than in response to external cues such as reminders from parents)[82], which is essential for getting tasks done without relying exclusively on explicit external cues (such as reminders from parents). Thus, age-related improvements in executive function might help children to act on their goals and reduce procrastination.

Developing self-control or emotion regulation abilities might also reduce procrastination in children. For instance, delay of gratification (postponing immediate rewards in favour of larger later rewards) might be central to reducing procrastination, which requires doing something less pleasant now (completing an aversive task) for later rewards rather than postponing the task at hand in favour of a more immediately gratifying alternative.

In addition, the development of emotion regulation skills might result in less need to repair negative mood triggered by an undesirable task. Although children start to experience some self-conscious emotions, such as shame or guilt by 3 or 4 years of age[109] and regret by 6 years of age[110], the ability to regulate such negative emotions takes more time to develop. Adolescence is a pivotal period for the development of emotion regulation owing to maturation of the prefrontal cortex[111,112]. In particular, during adolescence, children learn and sharpen emotion regulation strategies such as reappraisal (changing the way one thinks about a given situation)[111].

Mutual implications of child and adult research

Building on the reviews of child and adult procrastination research that have been conducted independently, we now discuss their mutual implications for definitional and measurement issues, theoretical development, and intervention efforts.

Implications for definitions and measurement

According to the prevalent multicomponent definition, procrastination is the voluntary decision to delay a task unnecessarily despite intending to complete that task and expecting that there will be future negative consequences for the delay. However, developmental research highlights a need to reconsider such a restrictive view of procrastination.

First, young children are not fully equipped with all the abilities needed to meet some of the requirements of this definition. Most fundamentally, children cannot provide accurate and reliable self-reports before 5 or 6 years of age[77]. Although some research has used parental ratings to assess procrastination in children[60,61], they are necessarily indirect reflections of children's intentions or thoughts. Thus, it is impossible to meet many of the subjective criteria required in the multicomponent definition developed for adult procrastination.

Second, even if children are old enough to introspect and report their thoughts, it is unclear whether they consciously consider their actions and consequences before postponing a task. For example, given that most targets of procrastination in young children are driven by what parents ask of them (for example, brushing their teeth), children's actual intentions to complete these tasks might be weak or, in some cases, absent, even though they probably recognize that these tasks have some value. Similarly, although children might sometimes consider future negative consequences (for example, being scolded), they might not always do so, especially when alternative, more pleasurable activities are readily available.

Thus, according to the multicomponent definition, many instances of behavioural delays in young children would not qualify as procrastination. In fact, as long as procrastination is defined in a strict, all-or-none manner (Fig. 1), it logically follows that young children delay tasks but never procrastinate; only when they later become capable of reflecting on and reporting their own thoughts can they suddenly start procrastinating. From this perspective, behavioural delays in young children are fundamentally different from — and should be clearly distinguished from — 'genuine' procrastination in adults.

An alternative to this discrete view of the emergence of procrastination is that, despite failing to meet some criteria, behavioural delays in young children are early manifestations or precursors to procrastination exhibited later by adolescents and adults. This continuous view of procrastination emergence emphasizes the potential continuity among different forms of behavioural delays observed over the course of development (Fig. 3).

It is premature to propose a new definition of procrastination based on this alternative view. However, one promising direction for the field is to adopt a more flexible approach used to characterize fuzzy concepts that acknowledges both similarities and differences across manifestations of a particular underlying construct. For example, in the case of major depressive disorder, the commonly used diagnostic criteria specify the core features that must be present (either 'depressed mood' or 'loss of interest or pleasure') and other optional features, some of which must be present (for example, 'fatigue' or 'diminished concentration')[113].

A similar approach could be applied to defining procrastination. A German therapy manual[114] demonstrates the potential usefulness of this approach by proposing a set of diagnostic criteria for severe procrastination consisting of two core ('must-have') and additional (optional) symptoms[115,116]. Although these criteria were developed specifically for clinical treatment purposes, an analogous approach could be used to develop a set of core and optional criteria that are more broadly applicable to various instances of procrastination observed in both adults and children.

For example, delayed start or completion of a task is clearly a 'must-have' feature of procrastination, and recognizing the potential benefits of the task (instead of having a clear intention to perform the task) could also qualify as a must-have feature. However, all four subjective criteria specified in the multicomponent definition might be better categorized as optional rather than must-have. Future research is needed to develop such diagnostic criteria and identify other possible optional features that are not currently part of the multicomponent definition.

Moving away from the multicomponent definition makes the concept of procrastination fuzzier. Nevertheless, this less restrictive approach to defining procrastination has multiple advantages. Most importantly, it provides a common basis for studying procrastination-related behaviours in both children and adults as well as possibly even

in non-human animals (for example, pigeons[117,118]). Moreover, this approach better recognizes the reality that procrastination can have different manifestations in everyday settings (versus assuming that procrastination can only be manifested in one way, that is, when all component criteria are met). Finally, this approach better aligns with the fact that existing questionnaires do not assess all multicomponent definition criteria, thereby reducing the definition–measurement gap.

Theoretical implications

Although there are guiding theoretical frameworks for adult procrastination, such frameworks are currently lacking for procrastination in children. Developing theoretical frameworks will be important for characterizing and testing how and why procrastination changes with development as well as for developing age-appropriate interventions to reduce procrastination in children.

Such theoretical efforts can be guided by adult theories. In particular, adult theories can suggest research directions that can help to better specify the trajectories of procrastination emergence from childhood to adulthood. For example, according to temporal motivation theory[6,11], expectancy, value, delay and impulsivity all influence motivation to start a task. Future research could seek to elucidate developmental changes in how children mentally represent expectancy and value and how they jointly contribute to the subjective overall utility of a task alongside impulsivity and delay. It is possible that, when children have poor introspective abilities, their behaviours are strongly driven by impulsivity but other factors might begin to assert greater influence as children develop and start facing strict deadlines (for example, in their schoolwork). According to short-term mood repair theory[10,49], procrastination occurs in an attempt to escape a negative mood associated with completing an intended task. Future research could examine children's task-induced negative affect and the way they regulate (or fail to regulate) such emotional reactions to better understand the mechanisms underlying procrastination in children.

Conversely, the study of procrastination in childhood can also inform adult theories of procrastination. Specifically, developmental research can point to salient factors that drive procrastination in children that have been overlooked in adult theories. For example, the developmental changes in the targets and contexts of procrastination highlight the importance of considering procrastination in broader, often changing life circumstances. As they develop, children engage in an increasingly greater number of meaningful activities that must be pursued simultaneously (Fig. 3). However, adult theories of procrastination have so far focused on the pursuit of single goals, even though in real life many important (often competing) long-term goals must be pursued simultaneously[119,120]. Thus, adult models of procrastination might benefit from considering how the decision to postpone a single goal works in the context of pursuing multiple meaningful goals.

Developmental work can also inform adult theories about the process of returning to a to-be-performed task once it is postponed. For example, young children are heavily dependent on explicit adult cueing or scaffolding to revisit and complete postponed tasks[63,90]. However, adult theories do not consider this process. In particular, they neglect the role of context cues in prompting an individual to revisit a postponed task. Context cues include explicit self-generated or other-generated cues (for example, preset automatic reminders or email reminders, respectively) as well as cues that might not necessarily enter an individual's conscious awareness (for example, time of day, location, preceding behaviours or mood change)[121,122]. Context cues are critically important for the process of returning to a once postponed task because they trigger the retrieval of the goal or intention for a to-be-performed task stored in long-term memory.

In other domains of development, studying children has yielded unique insights into a range of cognitive processes that operate in adults[123–126] because these processes are masked by other strategies adults use or are evidenced in more subtle ways in adults (such as in reaction times rather than errors). Thus, studying children's procrastination should be informative for adult theories of procrastination as the above examples illustrate.

Implications for interventions

Procrastination is complex and involves many contributing factors. Consequently, developing effective ways to help people overcome procrastination – especially severe, habitual forms of procrastination many adults have acquired over the course of their lives – is not easy.

One obvious implication of taking a developmental perspective is that intervening early by targeting children – when procrastination has not fully emerged – might be important for effectively minimizing future procrastination. The idea of intervening early has long been popular[127] and applied to various domains, especially in education[128,129]. In light of the evidence for genetic predispositions for procrastination[24,30], it might be particularly beneficial to provide targeted preventative interventions to children who are probably susceptible to developing severe procrastination tendencies later in life. Given similar correlates of procrastination in children and adults, intervention approaches effective for adults might also be effective for children, even though adjustments would obviously be needed to make specific interventions age appropriate.

One possible intervention approach is to focus on a known correlate of procrastination (such as executive function) and assume that any training-related improvement in the correlate will lead to a reduction in procrastination. Although this approach might have some intuitive appeal, studies designed to train executive function (especially working memory) in both adults[130] and children[131,132] have found that improved performance on trained executive function tasks does not transfer to other domains, especially when an active control condition is used. Given this lack of far transfer effects, executive function training is unlikely to be effective in reducing procrastination.

Another approach is to focus on therapy-based interventions (such as cognitive behavioural therapies) given the meta-analytic finding that therapy-based interventions tend to produce the largest reductions in procrastination[55,56]. This approach is important for the treatment of individuals with severe procrastination problems, especially if they also experience strong negative affect (for example, severe self-criticism) or mental health challenges (for example, depression or anxiety). However, the therapy-based approach is limited in some important ways: not everyone has easy access to therapy (for example, due to cost); attending therapy sessions might be impractical for younger children; and therapy requires guidance from trained therapists and therefore cannot be readily implemented by other adults such as parents or teachers. Thus, the therapy-based approach needs to be supplemented with other more accessible and easily implementable interventions.

We identify two complementary approaches to procrastination interventions that might fill this need. First, in light of the observation that environmental factors can contribute to procrastination in both adults and children, it might be possible to modify the environment to make it less 'procrastination friendly'. This approach is consistent with the intriguing finding that adults who score higher on trait self-control

tend to rely more on automatic habits and less on their self-control (willpower) or executive abilities to guide their everyday behaviours[133,134], in part because they 'neutralized' temptations in their environment and therefore experience fewer unwanted desires[122]. Consistent with the idea that context cues have important roles in procrastination, this finding suggests that, instead of focusing solely on the procrastinating individual, the surrounding environment might be an important avenue for intervention.

In fact, the growing developmental literature on the effect of cultural habits[135], social norms[136] and social support[137–139] on children's self-control suggest that teachers and parents might have a key role in creating environments that discourage procrastination (for example, by establishing norms and encouraging certain habits). Parallel proposals have been made in the adult literature. Specifically, instructors can make students' learning environments less procrastination friendly by making small, easily implementable changes to their instructions (for example, breaking down assignments into concrete steps and implementing shorter, regular deadlines)[58,140,141].

Second, it might be possible to reduce procrastination by teaching simple procrastination-reducing strategies and letting individuals practice using them until they become automatic and habitual. The idea is to provide individuals with simple compensatory strategies for circumventing the hypothesized causes of procrastination, rather than (unrealistically) attempting to eliminate the causes themselves (such as negative mood resulting from task aversion).

For example, having a 'starting ritual' (such as using a timer to start working on a task for a certain duration[142,143]) is an easy-to-implement strategy that might be effective for getting started on a task despite feeling some task aversion[140]. With appropriate guidance from parents or teachers (for example, gamifying the process or providing rewards), such techniques could also be used by children. Teaching simple strategies to engage in various forms of reappraisal, such as distancing and reinterpretation (for example, asking children to take another person's perspective by posing a question such as "what would Batman do?"[144,145]) might also be effective in reducing children's[145] as well as adults'[146] negative task-induced emotions[147] and thereby discourage them from 'giving in' to short-term pleasure.

Although these strategies are intuitively appealing, they need to be practised repeatedly so that adults or children can reliably apply the techniques at the right time and, in the case of children, independently without adult cueing. Moreover, a multipronged approach in which multiple complementary strategies are taught and practised might maximize their effectiveness[140]. Ultimately, the effectiveness of these strategies needs to be tested in rigorous intervention research.

Box 4 | Using experience-sampling methodology in procrastination research

Experience-sampling methodology[207] — also called ecological momentary assessment — involves regularly probing people's experiences in daily-life contexts as they occur. It relies on self-reports, but those reports are specific to thoughts or experiences that are temporally close to each probe. Experience-sampling methodology is therefore well-suited to exploring the in situ dynamics surrounding the target processes and has been used to study constructs related to procrastination such as prospective memory[208,209], self-control[134,210–212], emotion regulation[213,214], and behavioural and mental habits (for example, social media access[215] and ruminative thinking[216], respectively).

Experience-sampling data can have a critical role in future conceptual and theoretical development of procrastination in two important ways. First, experience-sampling data can be used to specify which of the multicomponent definition criteria (besides delay) are met when an individual postpones a task in their daily lives. With experience-sampling methodology, researchers can quantify the extent to which decisions to postpone a task meet each criterion. Such information can then be leveraged to test whether restricting analyses to only instances of procrastination that meet all criteria has any distinct explanatory advantages in accounting for some target outcome variables over adopting a less restrictive view. If not, such evidence would weaken the need for adopting a strict multicomponent definition.

Second, experience-sampling methodology can be used to simultaneously examine across-individual effects (reflecting stable individual differences) and within-individual effects (reflecting more fleeting situational influences), the latter of which have so far been neglected in procrastination research. Although within-individual factors could reflect some idiosyncratic influences (unique to each individual) or random noise, they could also be systematic (reflecting fatigue levels or other task demands) and even interact with across-individual factors (for example, a non-impulsive individual who usually does not procrastinate might occasionally put off a task when feeling stressed).

The few existing experience-sampling studies of procrastination[217–223] in adults provide examples of how examining within-individual, situational influences can provide new insights into how procrastination operates. For example, a study on smartphone use conducted over 30 days[221] documented that participants were more likely to report a delay in performing a task after spending more time on their smartphone or after receiving more notifications, suggesting a close association between procrastination and smartphone use (a reliable source of immediate pleasure that many people reach for automatically out of habit).

In another study, each individual's behavioural patterns were statistically modelled (based on both across-individual and within-individual factors) and then those individually tailored models were used to predict the respective future procrastination behaviours of these individuals[218]. Importantly, for many participants, future procrastination behaviours were predicted by both person and situational factors, suggesting that stable trait-level factors and more transient situational (contextual) factors contribute to whether an individual decides to put off a task at a given moment. Furthermore, the best predictor of an individual's future procrastination varied considerably across participants, suggesting that there is a substantial amount of idiosyncratic influence on procrastination unique to each individual. This finding makes sense given that people differ greatly in their living environments, daily activities, habits, likes and dislikes; consequently, the main 'triggers' for procrastination could differ from one person to another[163].

Summary and future directions

We identified important similarities and differences between procrastination in adults and in children. The correlates of procrastination in children are remarkably similar to those in adults, suggesting continuity between the forms of procrastination across development. However, the nature and targets of procrastination in children change as their environments change and as various procrastination-relevant abilities emerge. Importantly, research on procrastination in adults and in children can illuminate each other and can contribute to definition and measurement issues, theory, and interventions. Reviewing these lines of research also suggests important future research directions.

First, more research is needed to better characterize the developmental trajectories of procrastination. Most existing studies of procrastination focus on a narrow age range, and there are no large-sample studies of procrastination in children conducted across a wide age range. Thus, rigorous studies (especially longitudinal) are needed to better specify to what extent different types of procrastination observed in young children and in later childhood or adolescence are related. Demonstrating substantial longitudinal associations between early and late forms of behavioural delay would support the continuous view of procrastination emergence.

Longitudinal studies are also needed to specify how various emerging abilities contribute to changes in procrastination and how it is overcome during development. In particular, certain abilities (such as future thinking) might promote or discourage procrastination. These opposing influences on procrastination arising from similar abilities need to be examined further. Given that children's brains (especially prefrontal cortical regions) undergo substantial changes during development, research that examines the neural basis of those emerging abilities and their potential relations to procrastination in children is also needed.

Second, we focused on procrastination in children and young adults but it is equally important to study older adults as well[119]. Interestingly, despite known age-related declines in some abilities, such as executive function[148,149] and prospective memory[150], cross-sectional evidence based on self-report questionnaires suggests that older adults generally procrastinate less than younger adults[8,151,152]. Understanding why this age-related decline in procrastination occurs, especially using longitudinal data[119], would support more comprehensive developmental models that cover the entire lifespan.

Third, it will be important to supplement self-report questionnaires with other ways of assessing procrastination, including objective measures and measures more appropriate for young children. In particular, future research needs to rely more on assessment tools that are better suited for capturing how procrastination actually occurs in everyday settings. To that end, experience-sampling methodology, which makes it possible to simultaneously examine across-individual (trait) factors that are stable across time as well as within-individual (state) factors that vary across different time points, will be highly beneficial for studying procrastination (Box 4). Given that experience-sampling data are often collected with smartphones, such assessment might be more suitable for studying older adolescents and adults, but it could also be used to study younger children with parental involvement[153,154].

Finally, procrastination research needs to make closer contact with the habit literature. Theoretically, habits can influence procrastination in three important ways. First, among many individuals, postponing intended tasks becomes a habit. Second, other well-established behavioural or mental habits (such as checking smartphones[155] or engaging in negative ruminative thinking[156]) can interfere with working on intended tasks, even among non-habitual procrastinators. Third, forming new habits might be an effective way to reduce procrastination. Despite such clear theoretical relevance and increasing recognition of the roles of habits in other related research domains (for example, self-regulated learning[157], self-control[158] and anxiety[159]), insights from the habit literature have not yet permeated procrastination research.

Habits are typically conceptualized as context–response associations that form owing to repetition of rewarded responses to specific cues[121,122,160]. Because short-term mood repair theory[10,49] already incorporates elements of reinforcement learning[43,161,162], it can provide an initial theoretical bridge to the habit literature. For example, a reminder (cue) about an aversive task can trigger a negative mood and a subsequent attempt to repair it (response). The resulting improved mood serves as an immediate reward that ironically reinforces the act of putting off that task[163] (Fig. 2b, bottom panel).

Considerations of habits are also important for intervention efforts. The habit literature offers a wealth of practical, evidence-based suggestions for how best to make or break habits. Moreover, a meta-analysis on the effectiveness of different types of behavioural change interventions[164] has shown that interventions targeting habits are the most effective. Thus, examining procrastination from a habit lens could help to develop effective interventions that promote positive, long-lasting changes.

For example, a habit perspective suggests that disrupting the chain connecting cues, responses and rewards is key to reducing the likelihood of postponing a task again in the future. This disruption can be accomplished in multiple ways[160], including changing cues or their saliency (for example, making cues for desirable actions more visible or removing cues for undesirable actions); making it more difficult to select a short-term pleasure alternative by introducing 'friction' to the cue–response association; and linking cues to new more desirable responses. These habit-changing strategies are highly compatible with the promising lines of future intervention efforts (changing environments and practising simple strategies) we suggested above.

What unites all four future directions suggested in this section is a strong need to go beyond viewing procrastination only as a stable trait. Although procrastination certainly has trait-like characteristics that should not be ignored, it is far from static. In fact, procrastination is dynamic[48] in that it is constantly changing as a result of various influences — lifespan development, environmental changes, situational influences and reinforcement learning — all operating simultaneously on different timescales. We hope that this Review provides a springboard for a shift toward adopting a more dynamic view of procrastination and studying procrastination across the entire lifespan.

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The authors declare no competing interests.

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