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Metacognition and Academic Procrastination: A Meta-Analytical Examination

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Abstract

Procrastination is a universal phenomenon that occurs to most individuals in various settings. Such prevalence of academic procrastination suggests a need for systematic research that documents potential factors that lead to academic procrastination and subsequently explores potential ways to reduce procrastination, such as metacognition. Grounded upon the Self-Regulatory Executive Function (Wells and Matthews in Cognit Emot 8(3):279–295. https://doi.org/10.1080/026999394084089421994), metacognition plays an essential role in explaining and predicting procrastination. As the first attempt, this study aims to review and synthesize past empirical findings on the relationship between metacognition and procrastination. Fifty-nine relevant articles involving a total of 23,627 participants were synthesized in this meta-analysis. Using the robust variance estimation, results showed significant small effect sizes of metacognition for passive procrastination (− .28), but not for active procrastination (.03). Further, different dimensions of metacognition showed different relation patterns with procrastination. In particular, metacognitive belief and metacognitive regulation were significantly associated with passive procrastination; however, metacognition (regardless the types) was not significantly associated with active procrastination. After controlling for all proposed moderators (grade level, individualistic index, and gender), no significant moderation effects were found in the overall metacognition–active procrastination relationship or metacognition–passive procrastination relationship. The implications of the findings were discussed.

Keywords Metacognition · Procrastination · Meta-analysis

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Introduction

Procrastination is a universal phenomenon that occurs to most individuals in various settings: academia (Muliani et al., 2020), sports (Infante Borinaga et al., 2019), everyday life (Ferrari & Roster, 2018), and in different forms: decisional (Ferrari et al., 2018), behavioral (Zarzycka et al., 2019), and etc. The present study focused on academic procrastination which was intended as a specific type of behavioral procrastination. It refers to the tendency to delay an intended course of study-related action despite the negative consequences of such a delay (Steel & Klingsieck, 2016). Typical cases of academic procrastination include preparing for exams and doing homework to the last minute and feeling discomfort out of this (Milgram et al., 1998). Past research has shown that at least 70% of college students procrastinated on academic tasks occasionally (Özer, 2011), and this procrastinatory behavior was associated with unsatisfactory academic performance and higher levels of stress and anxiety (Kim & Seo, 2015). Such prevalence of academic procrastination suggests a need for systematic research that documents potential factors leading to academic procrastination and subsequently explores potential ways to reduce procrastination.

Through the lens of self-regulation theory, procrastination is considered a self-regulation failure (Park & Sperling, 2012; Van Eerde & Klingsieck, 2018). The Self-Regulatory Executive Function (S-REF; Wells & Matthews, 1994) theory was the first to conceptualize metacognitive factors as control components of information processing that affect the development and persistence of psychological disorders (Spada et al., 2006). In this study, we examined academic procrastination and meta-analyzed the available research on whether and how they were related to the dimensions of metacognition. We examined this metacognition–procrastination link by using current theory and research grounded upon self-regulation as a guiding conceptual framework. From a theoretical perspective, discerning the potential convergent and divergent associations of metacognition and procrastination can expand current theory on the cognitive, affective, and behavioral self-regulation issues. From a practical perspective, understanding the extent to which procrastination and metacognition are related can shed light on how to view different forms of procrastination and address each from a metacognitive perspective.

Dimensions of Metacognition

Metacognition is a multidimensional phenomenon (Schraw, 1998). It consists of two main components, namely knowledge of cognition and regulation of cognition (Ping et al., 2015). Knowledge of cognition (or metacognitive awareness) refers to what individuals know about their cognition or cognition in general whereas regulation of cognition (or metacognitive regulation) refers to a set of activities that help students control their learning. Knowledge of cognition plays an important role in monitoring the productivity of metacognition, and regulation of cognition deals with the actual enactment, such as planning, information management, comprehension monitoring, debugging, and evaluation (Schraw et al., 2006). Metacognitive beliefs, as an important component in the metacognitive system, are correlated with both metacognitive

knowledge (or metacognitive awareness) and metacognitive self-regulation (Matthews & Wells, 2016). They can be viewed as rationalizations or coping responses. For example, learners can select challenging tasks and persevere with them, when they believe that they can accomplish the tasks with reasonable effort (Schunk, 1984). Metacognitive beliefs can be either positive or negative.

Positive metacognitive beliefs are concerned with the usefulness of rumination or coping strategies (Huntley & Fisher, 2016) that impact on cognition and internal states (Spada et al., 2007). Examples include beliefs such as "*Worrying helps to solve problems and to avoid unpleasant situations*" (Cartwright-Hatton & Wells, 1997) or "*Ruminating about the past helps to prevent future mistakes*" (Papageorgiou & Wells, 2001). In contrast, negative metacognitive beliefs describe the uncontrollability of thoughts and feelings (De Palo et al., 2017). These include thoughts such as "*Rumination could make me kill myself*" (Papageorgiou & Wells, 2001) or "*I could make myself sick with worrying*" (Cartwright-Hatton & Wells, 1997). In the current study, we sought to examine the metacognition-procrastination relationship in these three aspects (i.e., metacognitive awareness, metacognitive beliefs, and metacognitive regulation).

Active versus Passive Procrastination

Procrastination has been frequently studied in negative connotations, as a dysfunctional behavior or an irrational delay of behavior (Ferrari, 2001), due to historical reasons. Procrastination was originally viewed neutrally and could be considered as sagacious delay or wisely chosen restraint at the earliest stage (DeSimone, 1993, as cited in Kim et al., 2017). People who procrastinate typically have lower stress and less illness as long as the deadlines are far away (Tice & Baumeister, 1997), and were criticized due to commitments and deadlines as required in the eighteenth century when the industrial revolution grew, and this behavior has since then been considered as lazy, weak and even sinful by that time (Steel, 2007). However, in recent theories of procrastination, researchers started attending to different forms of procrastination to counterbalance the negative view. Indeed, some researchers reported the short-term benefits of procrastination, and suggested that procrastination does not necessarily predict task performance in a negative way (e.g., Kim et al., 2017; Kim & Seo, 2013).

One of the most widely recognized works along this research line was Choi and Moran's (2009) proposal of "active procrastination", as a contrast to the traditional or passive procrastination." It denotes a functional delay whereby an individual intentionally postpones his action and benefits from it (Alexander & Onwuegbuzie, 2007), including an individual's preference for time pressure, intentional decision to procrastinate, capacity to meet deadlines, and ability to achieve satisfactory outcomes (Kim et al., 2017). Alternative terms have also been developed to denote similar concepts, such as adaptive procrastination (Gendron, 2011; Westgate et al., 2017), positive procrastination (Klassen et al., 2008), the functional form of delay (Klingsieck, 2013), and intentional procrastination (Fernie et al., 2017), with nuances in the focus in the definition of each term. It was not our intention in this

study to argue for or against the use of any particular terminologies. Instead, we focused on the empirical studies that involved measures of metacognition and both forms of academic procrastination.

Metacognition and Procrastination

Extensive research has been conducted investigating what factors are likely to result in procrastination, including personality (Swaraswati et al., 2017), boredom coping strategy (Zhou & Kam, 2017), achievement goals (Deemer et al., 2018), perceived parenting style (Yip & Leung, 2016), and so forth. Since 2003 (e.g., Wolters, 2003) attention has been particularly paid to how one's metacognition was related to academic procrastination. According to Fernie et al. (2017) metacognitive model of procrastination, engagement in cognitive processes such as worry and rumination drains mental resources, reducing the ability to perform. These depleted mental resources are often misallocated through maladaptive attentional strategies (e.g., distraction) that make it even more difficult to initiate or complete the task at hand, further contributing to procrastination. Prior research has provided preliminary evidence that metacognition plays a role in procrastination, yet results are mixed.

This alludes to several conceptual issues regarding how both metacognition and procrastination were construed in past studies. For example, researchers who did not differentiate procrastination between an active and a passive form tended to find significant negative associations between dimensions of metacognition and academic procrastination (e.g., Corkin et al., 2011; Park & Sperling, 2012), wherein high procrastinators reported the deficiency of metacognitive and self-regulatory skills. When researchers viewed procrastination in different forms (i.e., active vs. passive), different relation patterns were observed between metacognition and active/passive procrastination. As active procrastinators were confident in their abilities to complete tasks under time pressure, they were more likely to employ metacognitive strategies (Corkin et al., 2011), and thus, a positive correlation was identified between active procrastination and metacognitive facets (Cao, 2012; Gendron, 2011).

In a similar vein, the procrastination literature has explicitly examined how it relates to the various aspects of metacognition. Regarding metacognitive awareness, average procrastinators tended to have lower levels of metacognitive awareness (Visser et al., 2018), as higher metacognitive awareness usually leads to better planning, assessing, regulating, and monitoring in the learning process (Anderson & Walker, 1991; Schraw & Dennison, 1994), especially when facing more difficult tasks (Taher Gholami & Jalaee, 2017). Thus, the higher a learner in the knowledge of cognition, the lower chance he/she is engaged in passive procrastination (Bedel, 2017).

Researchers posited that metacognitive beliefs was the most generalizable and robust predictor of a procrastination tendency (Park & Sperling, 2012), even in diverse cultural contexts (e.g., Eastern Asian and North American samples; Klassen et al., 2010). Indeed, a large body of studies have recognized the relationship between procrastination and metacognitive belief (Ghadampour et al., 2017; Zarei & Khoshouei, 2016). The process underlying this association could be due to the fact that attentional strategies are governed by metacognitive beliefs (Fernie et al.,

2016). Under negative metacognitive beliefs, cognitive processes including distraction, rumination and worry consume significant mental resources (Fernie, et al., 2016). This paucity of mental resources tends to lead to unintentional (or passive) procrastination (Fernie et al., 2018). Individuals with positive metacognitive beliefs, in contrast, are more likely to activate procrastination intentionally as a coping strategy to deal with given tasks.

Some researchers regard metacognitive regulation as a component of self-regulated learning that has significant negative relations with academic procrastination (San et al., 2016). Passive procrastinators differ from self-regulate individuals in regulating their cognition, as self-regulated learners possess skills that enable them to plan, monitor, and evaluate their learning progress (Wang et al., 2015). Indeed, the enhancement of metacognitive self-regulation shows great promise for the reduction of dilatory behavior, such as procrastination (Tice & Baumeister, 1997). In a nutshell, metacognition has an impact on academic procrastination through different mechanisms (Bashir & Gupta, 2018; Kavousian & Karimi, 2019). The purpose of this study was to present an overview of past empirical findings to deepen our understanding of this relationship.

Moderators of the Metacognition–Procrastination Relationship

Grade Level

From the executive function and self-control perspective, individual cognitive control continues to strengthen significantly throughout childhood and adolescence (Best & Miller, 2010). Accordingly, older children are more regulated and capable in using metacognitive strategy in learning (Miles & Stine-Morrow, 2004; Veenman & Spaans, 2005). This difference became more salient when comparing K-12 school children and university students, with the latter exhibiting a higher level of autonomy and self-regulation in learning (Thapa et al., 2013). Further, students reporting extreme procrastination were found to be more than double at the college level than at the high school level. In Clariana et al. (2012) study, procrastination experienced a significant and remarkable intensification in both the final year of secondary school and the first year of university, compared to the first year of high school and final year in university. However, others reported that procrastinators were somewhat more likely to be found in a younger student group (Steel, 2007; Van Eerde, 2003). Therefore, we considered grade level as a potential moderator for the relationship between metacognition and procrastination.

Gender Composition of the Sample

Else-Quest et al. (2006) meta-analysis of temperament indicated that females exhibited higher effortful control and they tended to procrastinate less. Indeed, gender variations in students' tendency to academically procrastinate were observed in several studies (Balkis & Erdinç, 2017; Steel & Ferrari, 2013), with male students procrastinating more. Some recent empirical evidence also showed that the relationship

between metacognition and academic procrastination was stronger for males than females, suggesting that metacognition or self-regulating processes may confer greater benefits to male students (Limone et al., 2020; Steel & Ferrari, 2013). However, several studies reported no gender differences in this regard (i.e., Hess et al., 2000; Motie et al., 2012). And Rodarte-Luna and Sherry (2008) even found that females procrastinated more frequently than males. These mixed findings indicated an inconclusive assumption with regards to whether students' tendency to procrastination was associated with their gender. Therefore, we considered gender as one potential moderator in this meta-analytic study due to previous mixed results.

Culture

Culture has been defined as the values, traditions, and beliefs, and has been confirmed its mediating effect on individual behaviors of a particular social group (American Psychological Association, 2003; Parsons, 2003). Within the metacognition literature, there have been strong arguments that cultural values influenced individuals' development of self-regulation and practices (Keller & Kärtner, 2013; Trommsdorff, 2010), and empirical studies have consistently supported significant cultural differences in students' use of metacognitive strategies (Salili et al., 2001; Tang & Neber, 2008). For example, Chiu et al.'s (2007) PISA (Programme for International Student Assessment) data revealed that students in Asian cultures reported a greater use of metacognitive strategies than American students, that is, the use of metacognitive strategies was more positively associated with collectivistic cultures. Therefore, we inferred that cultural difference would be a potential moderator in this study and hypothesized that the individualism-collectivism difference would moderate the metacognition-procrastination relation, with the relationship being stronger in collectivistic cultures.

Purpose of the Study

As the body of procrastination literature grows, we argue that understanding the nature of the metacognition–procrastination relationship has important theoretical and practical implications that deserve further clarification and investigation. Several meta-analytical studies have been conducted regarding procrastination in relation to other variables, such as mental health (Rozental et al., 2018), coping (Sirois & Kitner, 2015), perfectionism (Sirois et al., 2017), and academic performance (Kim & Seo, 2015). By and large, these meta-analyses showed that procrastination is detrimental to individuals' health, well-being, as well as achievement. Despite the repeated emphasis of the role metacognition plays in procrastination tendency and behavior, no systematic review has been conducted to consolidate the current literature on this issue. Theory and research to date support the notion that procrastination is associated with individuals' metacognition. There is a need, hence, for a more fine-grained investigation of these associations and their magnitude especially given the updated conceptualization of procrastination and various dimensions of metacognition. Also important is understanding why procrastinators do not follow their

metacognitive thoughts when making decisions about taking action towards their goals. Such insights can point towards possible strategies and interventions that may help procrastinators better plan their studies and achieve their academic goals more efficiently and effectively.

The current study addressed the questions of how procrastination is linked to metacognition by meta-analytically summarizing the evidence to date regarding the magnitude of the associations between procrastination and metacognition. We took a two-step approach to address this question. The first step involved assessing the magnitude and nature of the associations between procrastination and metacognition by searching the published and unpublished literature to find papers reporting relevant effects. These papers were then meta-analyzed to estimate the effects sizes and identify the factors that may account for possible heterogeneity in the effects between studies. This was examined by the different dimensions of metacognition (metacognitive awareness, beliefs, and regulation), and the type of procrastination (active vs passive procrastination).

The second step involved moderator analyses conducted to identify sources of heterogeneity in the effect sizes, namely, the grade level of the sample (K-12 student vs higher education), gender composition of the sample, and culture (individualism vs collectivism). With this meta-analysis, we aimed to contribute to the literature by providing an average effect size of quantitative studies on metacognition and procrastination, and offering a tentative answer to the question of whether metacognition actually helps alleviate passive procrastination or boost active procrastination. Our second contribution is to provide insight into the role of metacognition such that counselors, coaches, and others who aim to help procrastinators could obtain invaluable insights. Our findings offered implications for research on and guidance of those who suffer from passive procrastination by summarizing previous work and pointing out in what way metacognition affects procrastinatory behavior.

Methods

Literature Search

The literature search was performed in February 2021. The search strategy involved systematically reviewing peer-reviewed journal papers and dissertations identified in an initial search of PsycINFO, PsycARTICLES, the Education Resources Information Center, Education search Complete, and dissertation databases. We also handsearched key educational journals and tracked reference lists from relevant papers. The keyword "procrastination" was combined with words related to metacognition (e.g., metacognition, metacognitive awareness, metacognitive belief, metacognitive regulation, self-regulation, self-regulated learning). In order to identify more metacognition research in different cultural contexts, we also searched Chinese versions of the above English keywords (i.e., "主動拖延者/主动拖延者" OR "後設認知信念/后设认知信念" OR "拖延行爲/拖延行为" OR "元認知/元认知" OR "後設認知策略/后设认知策略" OR "學業拖延/学业拖延" OR "自我調節學習策略/自我调节学习策略" OR "拖延"), via Google Scholar and robust Chinese

databases including Wangfang data, China National Knowledge Infrastructure, and Airiti Library. The potential inclusion sources were first screened by examining the abstract and title, then we examined all of the potential sources more closely to determine whether the articles met the inclusion or exclusion criteria as elaborated below.

Eligibility Criteria

Papers were restricted to peer-reviewed journal papers, book chapters, and doctoral dissertations published between January 2003 and February 2021. We included book chapters and dissertations because they are consistently identified as grey literature which significantly makes important contributions in systematic review and meta-analysis, such as reducing publication bias and balancing empirical resources (Benzies et al., 2006; Mahood et al., 2014). Further, we limited our search to this period because the first group of influential studies on procrastination appeared in 2003 by Wolters in his pioneer work on understanding procrastination from a self-regulated learning perspective. The following criteria were used to identify articles for inclusion in the study.

1. Due to our language proficiency, all English or Chinese articles were preferred. However, we did not limit publications to these two languages. We contacted the corresponding authors of non-English or non-Chinese articles to request the necessary statistic information for our analyses, and we also used online translation tools to help us retrieve the statistical information in these publications.
2. Only studies with student samples from K-12 to higher education were included (participants' gender, race, age, and other demographic characteristics were not limited). The eligible studies should cover primary school students, secondary school students, college or university students.
3. This meta-analysis was restricted to self-reports of procrastination, as no studies adopted behavioral measures of procrastination when linking it with metacognition.
4. The settings in the studies to be included in this meta-analysis were restricted to academic study settings. Studies involving non-academic measures, such as everyday (Sadeghi et al., 2014; Spada et al., 2006), and general decision-making (e.g., De Palo et al., 2017; Fernie et al., 2016) were excluded.

The second author independently screened the abstracts of identified citations for eligibility. All authors then examined the full texts of potential papers to ensure their eligibility for inclusion. Where discrepancies arose, discussions were held until a consensus was reached. The PRISMA flow diagram for this selection process is illustrated in Fig. 1.

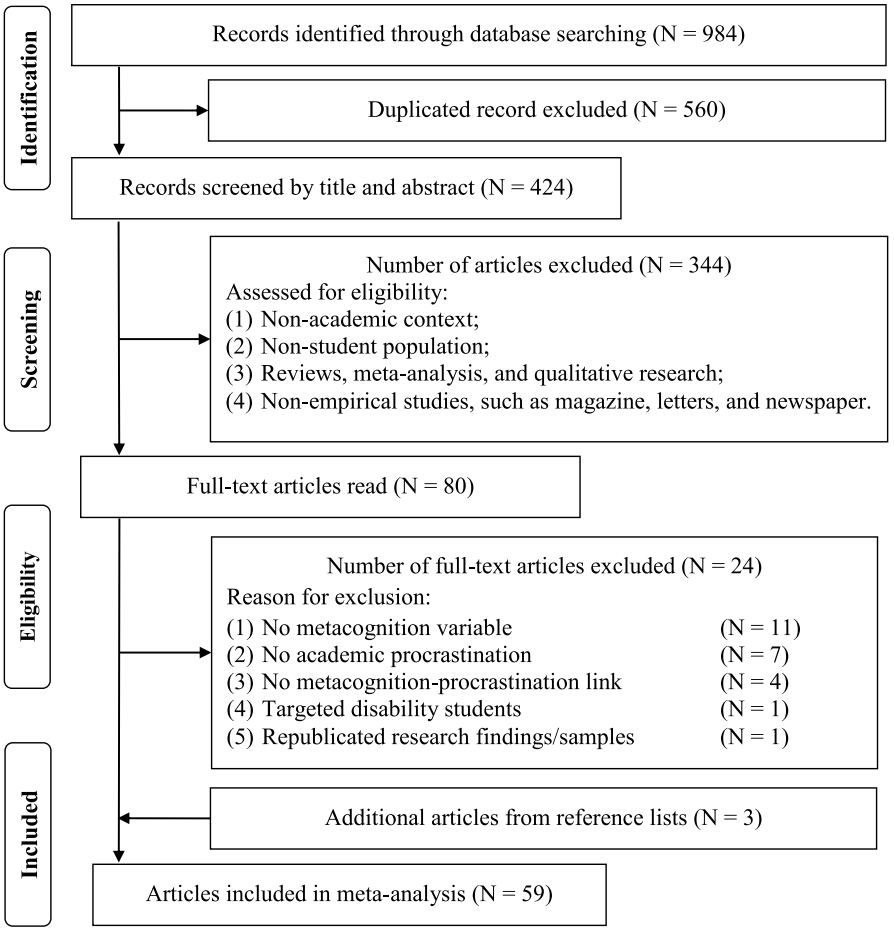

Fig. 1 The study selection process for systematic review and meta-analysis

Coding

We performed data coding in Microsoft Excel. All authors were involved in the data extraction and coding stage of meta-analysis. Despite minimal disagreements appeared at the coding stage, the first two authors cross-checked the accuracy of data analysis to ensure no errors were involved.

Effect Size

Pearson's correlation (*r* value) was used as the metric of effect size. When *r* value was not reported in the eligible studies, the available statistic information (i.e., a *t* or *F* value) was transformed into *r* using effect size calculators (Lenhard & Lenhard, 2016).

Type of Metacognition

Metacognitive literature has identified metacognitive awareness, metacognitive belief, and metacognitive regulation as distinctive aspects of this construct, another moderator was thus operationalized by setting 1 as metacognitive awareness, by setting 2 as metacognitive belief, and by setting 3 as metacognitive regulation. We reverse coded the effect sizes for negative metacognitive belief, because the original higher scores indicated a greater dysfunction in metacognition. In order to draw a consistent conclusion, we reverse coded these effect sizes such that higher effect sizes in this category (metacognitive belief as a whole) indicated a stronger relationship between students' metacognitive belief and procrastination. With regards to the type of procrastination, active procrastination was differentiated from passive procrastination. Wherein the authors did not explicitly specify it, we confirmed the type of procrastination by referring to the measures of procrastination.

Grade Level

Within education settings, two broad categorizations of grade levels are widely acknowledged: K-12 (primary and secondary school) and higher education (postsecondary to post-doc degree). This approach has been consistently adopted in meta-analysis reviews (Lam & Zhou, 2019; Zhou & Lam, 2019; Merchant et al., 2014). We thus operationally coded elementary school, middle school, and high school as the K-12 setting, and college/university and graduate study as higher education. Grade level was operationalized by setting 1 as the K-12 samples and 2 as the university samples.

Collectivism Versus Individualism

In consistent with prior research in cross-cultural meta-analyses (e.g., Sutton, 2020), the cultural factor (individualism vs collectivism) was coded as a continuous moderator (individualistic index ranging from 0 to 100), with higher scores representing a more individualistic culture (Hofstede, 1980).

Gender

Gender was coded as a continuous variable using the percentage (%) of female participants in each study, ranging from 0 to 100%.

Meta-Analysis Strategies

All statistical analyses were carried out using RStudio (version 4.0.3) to perform effect aggression and meta-regression ("*metafor*" and "*robumeta*" packages were performed). Several eligible studies in this meta-analysis provided more than one effect size (e.g., Mohammadi Bytamar & Saed, 2018; Wolters et al., 2017). We accounted for statistical dependencies of multiple effect sizes by using the

random-effects robust variance estimation (RVE; Hedges et al., 2010) via the *robumeta* package in RStudio (Fisher et al., 2018), since the non-independent and multiple effect sizes from a single study would threaten the validity of the interpretation of the results owing to bias (Cheung, 2019). The RVE method allows the meta-analysis study to include multiple effect sizes from a single study, and this method is often recommended in the meta-analysis literature (i.e., Tanner-Smith et al., 2016). The RVE method corrects the standard errors in counting the correlations between effect sizes from the same sample and provides accurate estimated effect sizes even when the precise nature of the correlation between effect sizes is unknown, without the need to combine or average the effect sizes from the same sample (Moeyaert et al., 2017). In order to test whether our results are sensitive to within-study correlation (the correlation rho with a range of plausible values between 0 and 1 in this meta-analysis) and select the value of rho for our meta-analysis, we performed sensitivity analysis, suggesting that our findings were robust across different values of rho. Therefore, we used the default value for the correlation rho (0.8) for the current meta-analysis, and this value has been supported as a typical value when the correlation between effect sizes was unknown (MacCann et al., 2020).

Three types of data analyses were performed in this study. First, an overall effect size across studies was computed and tested for statistical significance and homogeneity. As the studies used different effect size metrics, we converted all effects to *r* values (Rosenthal & DiMatteo, 2001). To present an easily interpretable metric with good statistical properties, all effect sizes were converted to r values (Rosenthal & DiMatteo, 2001). We followed Cohen's (1988) suggestion to indicate small, medium, and large effect sizes by 0.10, 0.30, and 0.50, respectively. When non-significant effect sizes were not available (either from the studies reviewed or through contact with the authors), *r* values were set to 0 (Borenstein et al., 2009). To assess heterogeneity in effect sizes, we computed Cochrane's Q to examine whether true differences existed in effect sizes across samples, and the I^2 statistic to find out the proportion of total variation across study estimates due to heterogeneity rather than chance (Borenstein, et al., 2009). We followed Higgins and Thompson's (2002) recommendation concerning the interpretation of I^2 by 0 (no heterogeneity), 25 (small heterogeneity), 50 (medium heterogeneity), 75 (large heterogeneity), and 100 (complete heterogeneity). Alongside I^2, we also provided the between-study sampling variance (τ^2) which was used to assign study weights in the random-effects model (Borenstein et al., 2009).

Second, the potential effects of publication bias were investigated via funnel plots. We also used Egger's regression test and visual inspection of a funnel plot to explore the impact of publication bias (Sterne et al., 2008). First, due to its accurate testing of publication bias, we conducted Egger's regression test (Egger et al., 1997). A non-significant result indicated a lack of publication bias (Lin & Chu, 2018). Further, we conducted the trim-and-fill method (Duval & Tweedie, 2000) to determine if our meta-analysis results would be affected after controlling for publication bias.

Finally, a series of moderator analyses were performed to investigate the extent to which participants' grade levels, types of metacognition, cultural backgrounds, gender ratio moderated the effects of metacognition on outcome measures. For categorical moderators, we directly entered dichotomous moderators (grade level: K-12

versus higher education) into the meta-regression model. For those categorical moderators with more than two categories (type of metacognition), we followed Cohen et al. (2013) approach to create several sets of dummy-coded variables to examine comparisons among categories. We also conducted subgroup analyses to show the relative magnitude of the difference in each categorical moderator. Further, as several moderators shared substantial overlaps and potentially acted as covariates, we conducted a meta-regression by putting all the proposed moderators into the meta-regression model simultaneously to examine which moderator had a unique effect on the association between metacognition and active/passive procrastination, while controlling for the effects of other moderators.

Results

Description of Studies Reviewed

The initial database search yielded 984 findings; 80 full-text papers were further assessed for eligibility; and 59 articles (60 studies) were ultimately considered relevant to this review. For the language of 59 eligible papers, twenty-eight were in English, followed by Chinese (15 articles), Persian (6 articles), Turkish (5 articles), Portuguese (2 articles), Spanish (2 articles), Japanese (1 article) and Korean (1 article). We categorized the extracted effect sizes into two groups: active procrastination (16.34%, $k = 25$), and passive procrastination (83.66%, $k = 128$).

Using the inductive approach, the first author identified three dimensions of metacognition and two types of procrastination. The inter-rater agreement among the authors was 100% for category identification. Then, all the reviewed studies were manually coded by the first two authors separately based on the agreed categorization and the inter-rater agreement reached 96%. Disagreements were resolved by discussing the studies within the two authors and arriving at a consensus regarding the appropriate coding. A full list of the studies included is presented in Appendix. Forest plots for metacognition (different types and overall) are presented in Fig. 2.

Research Design

Most of the articles adopted a cross-sectional design (52 studies), followed by a longitudinal design (2 studies; Xu, 2016; Ziegler & Opdenakker, 2018), mixed-methods design (Park & Sperling, 2012; Wäschle et al., 2014, Study 2), quasi-experimental design (Rashidzade et al., 2018; Richards, 2018), and semi-experimental design (Ghadampour & Beiranvand, 2019; Kavousian & Karimi, 2019). Eighteen studies involved K-12 samples (N = 8,51), and 42 studies involved university samples (N = 15,276).

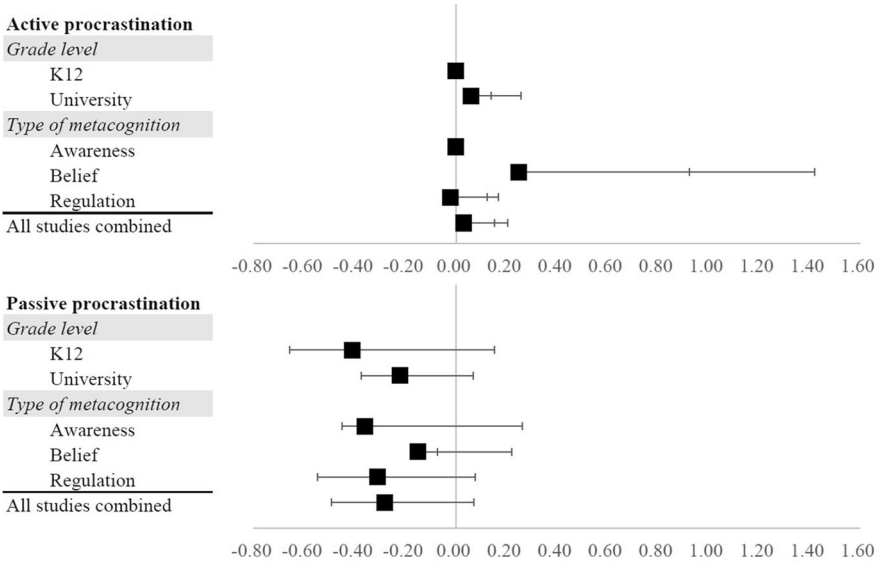

Fig. 2 Forest plot of dimensions of metacognition on procrastination (Pearson r). *Note*: No extracted studies had investigated the association between metacognitive awareness in active procrastination

Dimensions of Metacognition

All studies were first combined to determine the association between metacognition and active/passive procrastination. The meta-analysis of all studies showed that metacognition was non-significantly associated with active procrastination (weighted $r = 0.03$, 95% CI [−0.123, 0.175]), but significantly associated with passive procrastination (weighted $r = -0.28$, 95% CI [−0.353, −0.212], $p < 0.001$). Regarding the probability of heterogeneity, the significant heterogeneity Q statistics [active procrastination: $Q(24) = 615.18$, $p < 0.001$; passive procrastination: $Q(127) = 16{,}082.62$, $p < 0.001$] and large I^2 value [active procrastination: 93.08%; passive procrastination: 98.81%] suggested systematic between-sample variability between samples, supporting further substantial moderation testing (Viechtbauer, 2008). We further explored the three dimensions of metacognition separately. A summary of the findings in the reviewed studies is presented in Table 1.

Metacognitive Awareness

No extracted studies had investigated the association between metacognitive awareness in active procrastination. Three of the reviewed studies examined the effect of metacognitive awareness on passive procrastination (Bedel, 2017; Çikrikci, 2016; Wong, 2012). All studies have found the significant and negative effect of metacognitive awareness on students' passive procrastination. A meta-analysis of the above studies revealed that the level of metacognitive awareness was significantly associated with passive procrastination (weighted $r = -0.36$, 95% CI [−0.623, −0.092], $p < 0.05$).

Table 1 Summary of key findings

Variables	Total number of studies	Number of studies by grade level	Total number of participants	Summary of findings across studies
Metacognitive awareness			732	
Passive procrastination	3	k = 1 (K-12) k = 2 (University)		Metacognitive awareness significantly reduced student's passive procrastination in both K-12 and university samples (PO = 0; NG = 3; NS = 0)
Metacognitive belief			14,490	
Active procrastination	5	k = 0 (K-12) k = 5 (University)		With regards to students' metacognitive beliefs, mixed results were found at university level. Positive relationships were observed in the British sample; and the negative relationship was found in an Iran sample (PO = 2; NG = 1; NS = 2)
Passive procrastination	45	k = 2 (K-12) k = 43 (University)		Metacogntive beliefs significanlty and negatively influenced passive procrastination in Canadian and Singaporean samples In K-12 contexts, only negative relationships were found In university contexts, mixed results were found in American, Chinese, and Iranian samples (PO = 6; NG = 26; NS = 13)
Metacognitive regulation			35,801	
Active procrastination	21	k = 2 (K-12) k = 19 (University)		In K-12 contexts, only negative relationships were found in Iranian sample. Metacognitive regulation significantly negatively influenced students' active delay In university contexts, mixed results were shown. Students' effort regulation was significantly positively associated with their ability to meet deadlines, but mixed results were found in preference for pressure and outcome satisfaction (PO = 6; NG = 5; NS = 10)
Passive procrastination	79	k = 38 (K-12) k = 41 (University)		Metacognitive regulation was negatively related to students' passive procrastination in some studies In K-12 contexts, the negative relationships were only found in three collectivistic samples (Chinese, Korean, and Mozambican); mixed results were shown in Iranian and Turkish samples In university contexts, the negative relationships were found in Brazilian, Italian, Iranian, German, and Turkish samples; mixed results were shown in both individualistic (American and Spanish) and collectivistic (Chinese, Colombian and Japanese) samples (PO = 5; NG = 68; NS = 6)

k, number of correlations including in the analyses; PO, studies with positive results; NG, studies with negative results; NS, studies with non-significant results

Metacognitive Belief

Among the twelve of the reviewed studies that examined the effect of metacognitive belief on active/passive procrastination, five studies showed mixed results (Cao, 2012; Ghadampour et al., 2017; Hosseini & Khayyer, 2009; Mohammadi Bytamar & Saed, 2018; Mohammadi Bytamar et al., 2017). A meta-analysis of these studies revealed that the level of metacognitive belief was not significantly associated with active procrastination (weighted $r=0.25$, 95% CI [−0.676, 1.170]) or passive procrastination (weighted $r=-0.15$, 95% CI [−0.371, 0.076]). The weighted average correlation for active procrastination and passive procrastination appeared not to be representative, due to a significant and high level of heterogeneity between the studies: $I^2=88.75\%$ for active procrastination and $I^2=98.72\%$ for passive procrastination.

Metacognitive Regulation

Among forty-five of the reviewed studies that examined the effect of metacognitive regulation on active/passive procrastination, seven studies investigated both active/passive procrastination (Corkin et al., 2011; Ding et al., 2015; Ghadampour & Beiranvand, 2019; Richards, 2018; Wolters et al., 2017; Yamada et al., 2016; Zheng et al., 2020) and ten studies showed mixed results (Ding et al., 2015; Escolano-Pérez et al., 2017; Gendron, 2011; Kavousian & Karimi, 2019; Kim & Seo, 2013; Li et al., 2019; Wolters, 2003, Study 1; Wolters et al., 2017; Yamada et al., 2016; Zheng et al., 2020). A meta-analysis of the above studies revealed that the use of metacognitive regulation was not significantly associated with active procrastination (weighted $r=-0.02$, 95% CI [−0.190, 0.144]), but significantly associated with passive procrastination (weighted $r=-0.31$, 95% CI [−0.387, −0.239], $p<0.001$). However, the weighted average correlation for active procrastination and passive procrastination appeared not to be representative, due to a significant and high level of heterogeneity between the studies: $I^2=93.31\%$ for active procrastination and $I^2=98.73\%$ for passive procrastination.

Grade Level as a Moderator

Based on our extracted effect sizes in a relationship between metacognition and active procrastination, there was only one study (Ghadampour & Beiranvand, 2019) that has been conducted in the K-12 context. Therefore, we only conducted the moderator analysis of grade-level for passive procrastination. The K-12 group consisted of 41 effect sizes, and the university group consisted of 87 effect sizes. As shown in Table 2, results showed a significant negative effect size in both K-12 samples (weighted $r=-0.41$, 95% CI [−0.563, −0.247], $p<0.001$), and university samples (weighted $r=-0.22$, 95% CI [−0.290, −0.155], $p<0.001$). The meta-regression results (see Table 3) further confirmed that the relationship between metacognition and passive procrastination did not vary across grade level, although the effect

Table 2 Univariate moderation tests of categorical and continuous variables for the association between metacognition and active/passive procrastination

Moderator	*m*	*k*	*r*/*B*[a]	95% CI	τ^2	I^2
Active procrastination	11	25	.03	[−.123, .175]	.04	93.08
Categorical variables						
Grade level						
K-12	1	2	/	/	/	/
University	10	23	.06	[−.079, .199]	.04	93.19
Type of metacognition						
Awareness	/	/	/	/	/	/
Belief	2	4	.25	[−.676, 1.170]	.04	88.75
Regulation	9	21	−.02	[−.190, .144]	.04	93.31
Continuous variables						
Individualistic index	11	25	−.04	[−.205, .129]	.05	93.51
Gender (Female ratio)	8	21	.05	[−.151, .256]	.06	95.21
Passive procrastination	58	128	−.28***	[−.353, −.212]	.12	98.81
Categorical variables						
Grade level						
K-12	19	41	−.41***	[−.563, −.247]	.09	98.85
University	39	87	−.22***	[−.290, −.155]	.06	96.61
Type of metacognition						
Awareness	3	3	−.36*	[−.623, −.092]	.01	72.29
Belief	11	46	−.15	[−.371, .076]	.01	98.72
Regulation	45	79	−.31***	[−.387, −.239]	.11	98.73
Continuous variables						
Individualistic index	58	128	.01	[−.041, .060]	.12	98.77
Gender (female ratio)	51	107	.09*	[.019, .162]	.10	98.65

m, the number of eligible studies with independent samples; *k*, number of correlations including in the analyses; 95% CI, 95% confidence interval for the pooled effect size. All the analyses were run separately with using robust variance estimation approach via *robumeta* package in RStudio

*$p < .05$, ***$p < .001$

[a]*r* is used for categorical moderators, while *B* is used for continuous moderators

sizes tended to be larger for K-12 student samples, compared to university student samples.

Culture as a Moderator

The individualistic index was distributed evenly across the studies. The mean individualistic index was 46.42, as most studies were conducted in the United States (11 studies), China (12 studies), and Iran (11 studies). As shown in Tables 2 and 3, the meta-regression results indicated that the individualistic index did not play a significant moderating role in the relationship between metacognition and active/passive

Table 3 Multilevel regression model on the association between metacognition and active/passive procrastination

Moderator	*B*	*SE*	95% CI	*t*
Active procrastination ($m = 8$, $k = 21$, $\tau^2 = .09$, $I^2 = 95.31\%$)				
Intercept	.38	.15	[−.246, .101]	2.59
Regulation (belief as the reference level)	−.37	.18	[−1.062, .331]	−2.00
Gender (female ratio)	−.01	.10	[−.385, .370]	−.08
Individualistic index	−.15	.09	[−.530, .225]	−1.77
Passive procrastination ($m = 51$, $k = 107$, $\tau^2 = .08$, $I^2 = 98.13\%$)				
Intercept	−.39	.11	[−.825, .040]	−3.71
University (K-12 as the reference level)	.01	.13	[−.266, .277]	.04
Type of metacognition (awareness as the reference level)				
Belief	.21	.13	[−.207, .632]	1.69
Regulation	.07	.09	[−.299, .430]	.74
Gender (female ratio)	.09	.05	[−.023, .201]	1.78
Individualistic index	−.01	.03	[−.064, .047]	-.32

m, the number of eligible studies with independent samples; *B*, unstandardized regression coefficient; 95% CI, 95% confidence interval for the pooled effect size; *t*, *t* statistic for each moderator. All moderators were entered in one model for activeprocrastination and passiveprocrastination with using robust variance estimation approach via *robumeta* package in RStudio

procrastination, suggesting that the relationship between metacognition and active/passive procrastination did not vary substantially by cultural background.

Gender as a Moderator

The mean ratio of females was 61.43%, and the reviewed studies tended to have slightly more female than male participants. Only 13 studies recruited more male students than females. As shown in Table 2, gender did not significantly moderate the metacognition–active procrastination link, while it significantly moderated the effect of overall metacognition on passive procrastination ($B = 0.09$, $p < 0.05$). The meta-regression results (see Table 3) further confirmed that the relationship between metacognition and passive procrastination did not vary across gender.

Meta-regression Model

After entering all proposed moderators in the meta-regression model simultaneously, no significant moderators were observed in the model (see Table 3).

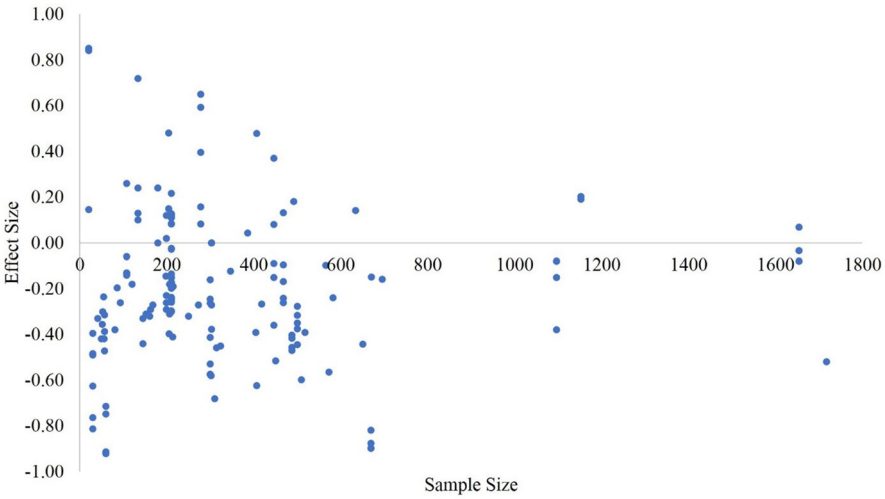

Fig. 3 Funnel plot of publication bias analysis (Pearson r)

Publication Bias

The publication bias analyses were firstly performed via funnel plots (Goldberg et al., 2003). As shown in Fig. 3, nearly 42% of the reviewed studies used a sample size smaller than 300, and they demonstrated a wide range of effect sizes (ranging from −0.92 to 0.85). The funnel plot showed that 26 extracted effect sizes were more than 0.50; approximately 12% of the effect sizes were less than 10. The funnel plot showed a roughly even distribution of outcome, with a few out of the range. Further, we computed the visual scatterplots to indicate potential bias in the overall effect size estimation for active/passive procrastination outcomes (see Figs. 4, 5). The two scatterplots formed asymmetric funnels, indicating potential bias that required a more in-depth investigation.

The trim-and-fill test resulted in 4 trimmed and filled effect sizes for active procrastination, with an adjusted estimated average weighted $r = 0.15$ [0.030, 0.261]. In terms of passive procrastination, the trim-and-fill analysis identified no missing studies for passive procrastination, indicating that no risk of publication bias would affect our results on passive procrastination. The Egger's test showed significant results for both active procrastination ($z = -4.04$, $p < 0.01$) and passive procrastination ($z = 2.22$, $p < 0.05$). We, therefore, concluded that publication bias was a concern in the current meta-analysis results on active procrastination. Both the trim-and-fill test and the Eggers test indicated that there is a strong publication bias in the current meta-analysis results on active procrastination. The publication bias also occurred in passive procrastination.

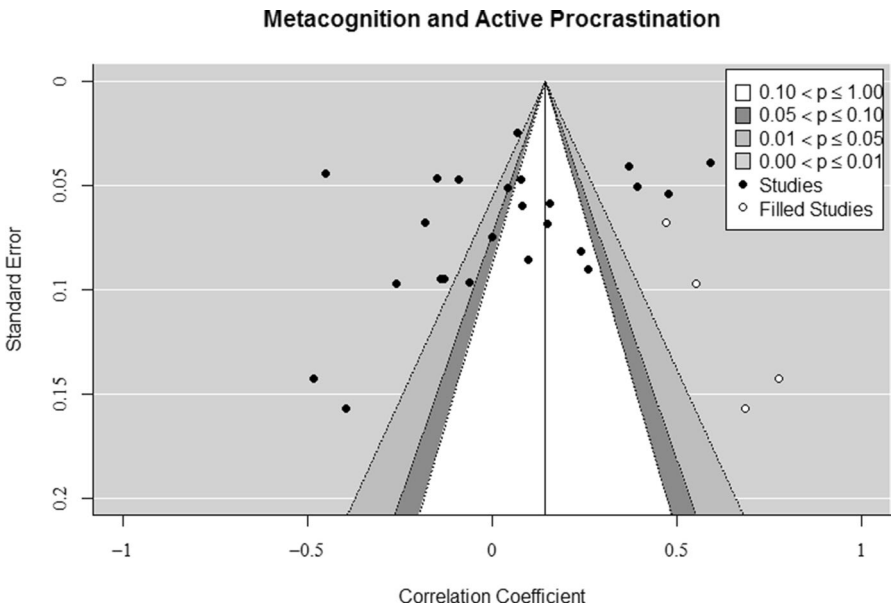

Fig. 4 Contour-enhanced funnel plots with trim-and-fill results for active procrastination. *Note.* Each black dot (hollow) represents an individual effect size and is positioned according to its Pearson's correlation *r* effect size (x-axis) and standard error (y-axis). Confidence intervals represent non-significance of study effects within the area (*p* value: white = .10, dark gray = .05, gray = .01, and light gray = .001) while the dashed line represents the estimated effect size. Trim-and-fill analysis yielded 4 trimmed or filled effect sizes, and the significant Egger's regression test suggested ($z = -4.04$, $p < .01$) small study effects

Discussion

Students' academic procrastination is a widespread phenomenon and it can lead to poor academic performance (Kim & Seo, 2015) and psychological illness (Martinčeková, & Enright, 2020). Grounded in Wells and Matthew's (1994) Self-Regulatory Executive Function theory and empirical findings that supported the effective role of metacognition in procrastination (San et al., 2016; Zarei & Khoshouei, 2016), we conducted this meta-analysis to present an overview of the relations between metacognition and academic procrastination. First, we found an overall significant and negative relation between metacognition and passive procrastination (weighted $r = -0.28$), but not for active procrastination (weighted $r = 0.03$). It appeared that metacognition played a more critical role in reducing passive procrastination, but not so effective in influencing the tendency of active procrastination. Although researchers have argued for certain desirable attitudinal and behavioral characteristics possessed by active procrastinators (Chu & Choi, 2005), our meta-analysis results revealed that these procrastinators could also possess other undesirable traits that were not conducive to the use of metacognition. This clearly warrants further investigation.

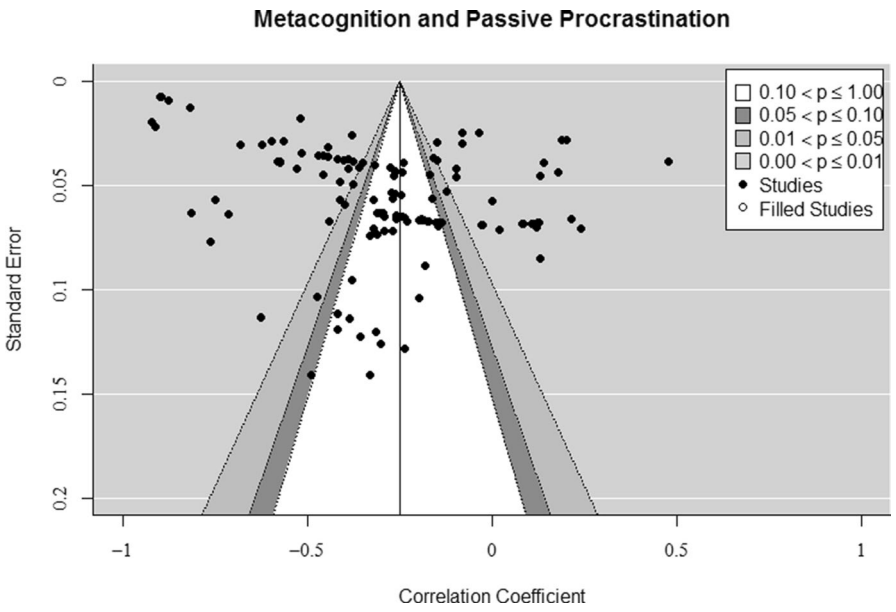

Fig. 5 Contour-enhanced funnel plots with trim-and-fill results for passive procrastination. *Note.* Each black dot (hollow) represents an individual effect size and is positioned according to its Pearson's correlation *r* effect size (x-axis) and standard error (y-axis). Confidence intervals represent non-significance of study effects within the area (*p* value: white = .10, dark gray = .05, gray = .01, and light gray = .001) while the dashed line represents the estimated effect size. The trim-and-fill analysis identified no missing studies for passive procrastination, but the significant Egger's regression test suggested ($z = 2.22$, $p < .05$) small study effects

When we zoomed into different dimensions of metacognition, we found that metacognitive regulation (weighted $r = -0.31$) was significantly and negatively associated with passive procrastination. This aligns with Chu and Choi's (2005) report that passive procrastinators were often unable to effectively manage time and showed poor self-regulatory skills. It is thus reasonable that students with a high level of metacognitive regulation (such as how individuals regulate their cognition through a set of monitoring and planning strategies, see Schraw & Moshman, 1995) tended to procrastinate less.

Consistent with Schraw's (1998) remark that metacognitive awareness was effective in directing cognition and monitoring cognitive processes and outcomes, and further reduced the tendency of procrastination, we also found that metacognitive awareness (weighted $r = -0.36$) was significantly negatively associated with passive procrastination. Together with several other prior studies (Çikrikci, 2016; Siddiqui et al., 2020; Wong, 2012), the findings suggested that students' knowledge of cognition could provide opportunities for them to better monitor their learning. In contrast, metacognitive belief was not found to be significantly related to passive procrastination. Possibly, the different ways of operationalizing metacognitive belief across studies may have balanced out the positive and

negative impact on procrastination observed in different studies: some chose to differentiate positive beliefs from negative beliefs; and others chose to examine the different facets of this construct (i.e., uncontrollability, cognitive confidence, cognitive self-consciousness, Hosseini & Khayyer, 2009). A consistent way of operationalizing metacognitive beliefs could be considered in future studies.

We previously suggested that the relationship between metacognition and procrastination could vary by individual (grade level and gender) and contextual (culture) factors. Unexpectedly, we did not find any significant moderation effects on the metacognition-procrastination relation. The non-significant results implied that the effects of metacognition on students' procrastination did not vary substantially between female and male students, between K-12 and university students, or among students from diverse cultural backgrounds. Despite the non-significant moderation effect for gender ratio, the gender ratio was found to be positively related to the magnitude of effect size—as the number of female participants in the sample increased, the correlations between metacognition and procrastination became stronger; and, conversely, as the number of male participants increased, the correlations became weaker. This suggests that educators may need to pay more attention to male students when facilitating metacognition in order to reduce their passive procrastination. As the gender composition was not distributed evenly across the reviewed studies in this meta-analysis, more research in targeting at male students is thus recommended.

Overall, our results suggested that, among K-12 and university students, stronger metacognitive awareness and better metacognitive regulatory skills could confer a noteworthy advantage to reduce passive procrastination. Developing metacognitive awareness is an important part of helping learners become more effective and, importantly, more autonomous. Only when learners are conscious of how they learn can they identify the most effective ways of doing so. Similarly, training on metacognitive skills would allow students to better plan, monitor and reflect on their learning processes for achieving higher efficiency. Consequently, we call for more empirical studies in further exploring the mechanisms of relationships between metacognitive awareness/skills and academic procrastination.

Limitations and Future Directions

The current findings need to be interpreted with caution. First, the effect sizes in this meta-analysis were correlations and mostly from cross-sectional studies (88% of eligible studies). In the absence of sufficient longitudinal and experimental data, our results cannot support causal claims. Second, an underbalanced number of studies by their socio-cultural backgrounds (i.e., most of the studies were conducted in China, Iran, and the United States) could present challenges for generalizability. It is thus recommended to conduct more research in this area with other regions to provide a more holistic view. Third, our meta-regression results have not supported any significant moderators in explaining the association between metacognition and active/passive procrastination. However, the significant homogeneity test indicated the presence of moderators. Future research may also consider re-examining the role

of other potential moderators of the metacognition–procrastination relations. Last, a small number of studies were reviewed in some categories (e.g., metacognitive awareness and beliefs) in this meta-analysis, which presents challenges to reach strong conclusions involving the relationships between these very particular dimensions of metacognition and procrastination. Thus, the current interpretations are tentative, and more research in investigating the effectiveness of metacognitive awareness and metacognitive belief on students' procrastination is highly recommended.

Conclusions and Implications

The current study is the first systematic review on the relationship between metacognition and procrastination. Our findings have implications both in theory and practice. By theory, this study lays a foundation for future research on academic procrastination by pointing to the direction of emphasizing the role of metacognitive capabilities, particularly of regulating oneself, in buffering or sustaining behavior. Clearly, more empirical studies are needed in certain subareas in this field, such as the role of metacognitive awareness. The moderator analysis enables us to draw stronger conclusions that the enhancement of metacognitive awareness and regulatory skills is effective in reducing passive procrastination. Cognitive, motivational, and emotional reasons could be further examined in this process. Further, what has not been attended to, however, is how to map metacognition into the progressing theorization of procrastination by considering various forms of procrastination.

Students' grade level, gender, and cultural background did not influence the relationships between metacognition and procrastination, which offers practitioners a variety of intervention approaches for most subsets of the populations. Given the current findings, corresponding interventions can be developed with a focus on promoting metacognitive thinking and behaving in manipulating student procrastination intention and behavior. Empirical evidence supported that metacognitive skills training could overcome student academic procrastination (Seadati et al., 2017), such as the Metacognitive Therapy, with a focus on metacognitive thinking (Fernie et al., 2017) and cognitive-behavioral coaching (Karas & Spada, 2009), with a focus on the enhancement of metacognitive skills. More attention is clearly needed to be paid to how to monitor the active form of procrastination by allocating one's metacognitive sources. The eventual goal is to prepare students to be more aware of and more regulatory in their learning behavior and decisions.

Appendix

See Table 4.

Table 4 Systematic review table (alphabetical according to the first author)

Nos.	Author (s)	Sample	Research design	Dimensions of metacognition	Forms of procrastination
1	Bashir (2019)	University students in Jammu and Kashmir (N = 1152)	Cross-sectional	Metacognitive belief	Passive procrastination
2	Bayrak (2017)	University students in Turkey (N = 65)	Cross-sectional	Metacognitive regulation	Passive procrastination
3	Bedel (2017)	University students in Turkey (N = 145)	Cross-sectional	Metacognitive awareness; Metacognitive regulation	Passive procrastination
4	Behrozi et al. (2013)	1st grade high school male students in Iran (N = 300)	Cross-sectional	Metacognitive regulation	Passive procrastination
5	Cao (2012)	University students in United States (N = 134)	Cross-sectional	Metacognitive belief	Active procrastination; Passive procrastination
6	Çetin and Ceyhan (2017)	High school students in Turkey (N = 1718)	Cross-sectional	Metacognitive regulation	Passive procrastination
7	Cheng et al. (2010)	Undergraduates in China (N = 468)	Cross-sectional	Metacognitive belief	Passive procrastination
8	Cheng (2020)	University students in Taiwen (N = 582)	Cross-sectional	Metacognitive regulation	Passive procrastination
9	Chen et al. (2020)	University students in China (N = 893)	Cross-sectional	Metacognitive regulation	Passive procrastination
10	Çikrikci (2016)	High school students in Turkey (N = 273)	Cross-sectional	Metacognitive awareness	Passive procrastination
11	Corkin et al. (2011)	College students in United States (N = 206)	Cross-sectional	Metacognitive regulation	Active procrastination; Passive procrastination
12	Demir and Baloğlu (2020)	High school students in Turkey (N = 492)	Cross-sectional	Metacognitive regulation	Passive procrastination
13	Deng et al. (2020)	Undergraduates in China (N = 634)	Cross-sectional	Metacognitive belief	Passive procrastination

Table 4 (continued)

Nos.	Author (s)	Sample	Research design	Dimensions of metacognition	Forms of procrastination
14	Ding et al. (2015)	Undergraduates in China (N = 386)	Cross-sectional	Metacognitive regulation	Active procrastination; Passive procrastination
15	Escobar and Corzo (2018)	University students in Colombia (N = 407)	Cross-sectional	Metacognitive regulation	Passive procrastination
16	Escolano-Pérez et al. (2017)	Freshmen in Spain (N = 303)	Cross-sectional	Metacognitiveregulation	Passive procrastination
17	Fernie et al. (2018)	University students in United Kingdom (N = 204)	Cross-sectional	Metacognitive belief	Active procrastination
18	Fujuta (2010)	Undergraduates in Japan (N = 161)	Cross-sectional	Metacognitive regulation	Passive procrastination
19	Fulano (2017)—Study 1	10th to 12th graders in city of Maputo (N = 1000)	Cross-sectional	Metacognitive regulation	Passive procrastination
20	Gendron (2011)	Undergraduates in Canada (N = 108)	Cross-sectional	Metacognitive regulation	Active procrastination
21	Ghadampour et al. (2017)	University students in Iran (N = 324)	Cross-sectional	Metacognitive belief	Passive procrastination
22	Ghadampour and Beiranvand (2019)	Middle school students in Iran (N = 30)	Semi-experimental	Metacognitive regulation	Active procrastination; Passive procrastination
23	Gürgân and Gündoğdu (2019)	University students in Turkey (N = 405)	Cross-sectional	Metacognitive regulation	Passive procrastination
24	Gutiérrez-García et al. (2020)	High school students in Mexico (N = 52)	Cross-sectional	Metacognitive regulation	Passive procrastination
25	Hosseini and Khayyer (2009)	University students in Iran (N = 199)	Cross-sectional	Metacognitive belief	Passive procrastination

Table 4 (continued)

Nos.	Author (s)	Sample	Research design	Dimensions of metacognition	Forms of procrastination
26	Hsiao and Hsieh (2017)	7th to 9th graders in Taiwen (N = 488)	Cross-sectional	Metacognitive regulation	Passive procrastination
27	Kavousian and Karimi (2019)	Female high school students in Iran (N = 40)	Semi-experimental	Metacognitive regulation	Passive procrastination
28	Kim et al. (2013)	Senior high school students in Korea (N = 300)	Cross-sectional	Metacognitive regulation	Passive procrastination
29	Kim and Seo (2013)	Undergraduates in Korea (N = 278)	Cross-sectional	Metacognitive regulation	Active procrastination
30	Klassen et al. (2009)	10th and 11th graders in Canada (N = 310) and Singapore (N = 302)	Cross-sectional	Metacognitive belief	Passive procrastination
31	Li et al. (2019)	Undergraduates in China (N = 1096)	Cross-sectional	Metacognitive regulation	Passive procrastination
32	Limone et al. (2020)	University students in Italy (N = 450)	Cross-sectional	Metacognitive regulation	Passive procrastination
33	Mohammadi Bytamar and Saed (2018)	University students in Iran (N = 210)	Cross-sectional	Metacognitive belief	Passive procrastination
34	Mohammadi Bytamar et al. (2017)	University students in Iran (N = 210)	Cross-sectional	Metacognitivebelief	Passive procrastination
35	Motie et al. (2012)	1st grade high school male students in Iran (N = 250)	Cross-sectional	Metacognitive regulation	Passive procrastination
36	Park and Sperling (2012)	Undergraduates in United States (N = 41)	Mixed-methods	Metacognitive regulation	Passive procrastination
37	Rakes and Dunn (2010)	Graduate students in United States (N = 81)	Cross-sectional	Metacognitive regulation	Passive procrastination
38	Rashidzade et al. (2018)	Secondary school students in Iran (N = 60)	Quasi-experimental	Metacognitive regulation	Passive procrastination

Table 4 (continued)

Nos.	Author (s)	Sample	Research design	Dimensions of metacognition	Forms of procrastination
39	Richards (2018)	University students in United States (N = 126)	Quasi-experimental	Metacognitive regulation	Active procrastination; Passive procrastination
40	Sampaio et al. (2012)	University students in Brazil (N = 651)	Cross-sectional	Metacognitive regulation	Passive procrastination
41	Sheykholeslami (2016)	Undergraduates in Iran (N = 163)	Cross-sectional	Metacognitive regulation	Passive procrastination
42	Sun (2018)	Junior middle school students in China (N = 669)	Cross-sectional	Metacognitive regulation	Passive procrastination
43	Tseng (2017)	Master students in Taiwen (N = 518)	Cross-sectional	Metacognitive regulation	Passive procrastination
44	Valkyrie (2006)	University students in United States (N = 500)	Cross-sectional	Metacognitive regulation	Passive procrastination
45	Wäschle et al. (2014)—Study 2	Undergraduates in Germany (N = 49)	Longitudinal	Metacognitive regulation	Passive procrastination
46	Wei (2020)	5th to 6th graders in China (N = 510)	Cross-sectional	Metacognitive regulation	Passive procrastination
47	Wolters (2003)	Study 1: University students in United States (N = 168) Study 2: University students in United States (N = 152)	Cross-sectional	Metacognitive regulation	Passive procrastination
48	Wolters and Benzon (2013)	University students in United States (N = 215)	Cross-sectional	Metacognitive regulation	Passive procrastination
49	Wolters and Hussain (2015)	University students in United States (N = 213)	Cross-sectional	Metacognitive regulation	Passive procrastination
50	Wolters et al. (2017)	Undergraduates in United States (N = 446)	Cross-sectional	Metacognitive regulation	Active procrastination; Passive procrastination

Table 4 (continued)

Nos.	Author (s)	Sample	Research design	Dimensions of metacognition	Forms of procrastination
51	Wong (2012)	University students in Hong Kong (N = 314)	Cross-sectional	Metacognitive awareness	Passive procrastination
52	Wu (2012)	Undergraduates in China(N = 671)	Cross-sectional	Metacognitive belief	Passive procrastination
53	Xu (2016)	Junior middle school students in China (N = 573)	Longitudinal	Metacognitive regulation	Passive procrastination
54	Xu (2014)	Senior high school students in China (N = 418)	Cross-sectional	Metacognitive regulation	Passive procrastination
55	Yamada et al. (2016)	University students in Japan (N = 179)	Cross-sectional	Metacognitive regulation	Active procrastination; Passive procrastination
56	Zarei and Khoshouei (2016)	College students in Iran (N = 120)	Cross-sectional	Metacognitive belief	Passive procrastination
57	Zheng et al. (2020)	Undergraduates in China (N = 1654)	Cross-sectional	Metacognitive regulation	Active procrastination; Passive procrastination
58	Zhong (2017)	Undergraduates in China (N = 205)	Cross-sectional	Metacognitive regulation	Passive procrastination
59	Ziegler and Opdenakker (2018)	First-year students in regular secondary education in the Netherlands (N = 566)	Longitudinal	Metacognitive regulation	Passive procrastination

Data Availability The data and material are available upon request.

Declarations

Conflict of interest There is no potential conflict of interest in this research.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was provided for all individual participants included in the study.

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