Review

# Mental imagery of suicide and non-suicidal self-injury: A meta-analysis and systematic review

Hannah R. Lawrence [a,*], Emma G. Balkind [b], Julie L. Ji [c], Taylor A. Burke [d,e], Richard T. Liu [d,e]

[a] School of Psychological Science, Oregon State University, Corvallis, OR, United States of America
[b] Suffolk University, Boston, MA, United States of America
[c] School of Psychological Science, University of Western Australia, WA, Australia
[d] Massachusetts General Hospital, Boston, MA, United States of America
[e] Harvard Medical School, Boston, MA, United States of America

A B S T R A C T

*Background:* The vast majority of research on, and clinical assessment of, cognitions related to suicide and non-suicidal self-injury (NSSI) has focused on verbal thoughts. And yet, mental imagery is more realistic and emotionally arousing than verbal thoughts.
*Methods:* We conducted a systematic review and meta-analysis documenting the prevalence of suicidal and NSSI mental imagery and describing the content and characteristics of suicidal and NSSI mental imagery, links between suicidal and NSSI mental imagery and suicidal and NSSI behavior, and how to intervene on suicidal and NSSI mental imagery. Studies published through December 17, 2022 were identified through a systematic search of MEDLINE and PsycINFO.
*Results:* Twenty-three articles were included. Prevalence rates of suicidal (73.56%) and NSSI (84.33%) mental imagery were high among clinical samples. Self-harm mental imagery commonly depicts engagement in self-harm behavior and is experienced as vivid, realistic, and preoccupying. When experimentally induced, self-harm mental imagery reduces physiological and affective arousal. Preliminary evidence suggests that suicidal mental imagery is associated with suicidal behavior.
*Conclusions:* Suicidal and NSSI mental imagery are highly prevalent and may be associated with heightened risk for self-harm behavior. Assessments and interventions for self-harm should consider incorporating and addressing suicidal and NSSI mental imagery to mitigate risk.

## 1. Introduction

Self-injurious thoughts and behaviors (SITBs), or thoughts and behaviors related to harming oneself, are serious public health concerns. >700,000 people die by suicide each year (Fox, Millner, Mukerji, & Nock, 2018; WHO, 2021), a rate which is only increasing (Crosby et al., 2011). Even more prevalent is non-suicidal self-injury (NSSI), or harming oneself without intent to die, which occurs in 4–5.9% of adults (Plener et al., 2016) and 15–18% of adolescents (Swannell, Martin, Page, Hasking, & St John, 2014). Research on suicide and NSSI has predominately focused on the pathway from suicidal ideation to suicidal behavior (Kleiman, 2020) and from thoughts of NSSI to engagement in NSSI (e.g., Turner, Baglole, Chapman, & Gratz, 2019). Along with serving as risk factors for suicidal and NSSI behavior, however, suicidal and non-suicidal self-harm cognitions are impairing and distressing in their own right (Hepp et al., 2020; Kleiman, 2020; Oppenheimer, Glenn, & Miller, 2022). As such, there have been recent calls to prioritize the study of suicidal and NSSI cognitions (Kleiman, 2020; Oppenheimer et al., 2022) in hopes of preventing suicidal and NSSI behavior and concomitant suffering and impairment.

Self-harm cognitions have been broadly conceptualized as verbal thoughts about harming oneself, with the vast majority of research on, and clinical assessment of, suicidal ideation and NSSI cognitions focused on verbal mental sentences about suicide or NSSI. Definitions of suicidal ideation and NSSI cognitions describe them as *thoughts* of killing oneself (in the case of suicidal ideation) or injuring oneself without suicidal intent (in the case of NSSI cognitions) and gold standard measures of suicidal ideation and NSSI cognitions ask, "Have you ever had *thoughts*

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of killing yourself?" and "Have you ever had *thoughts* of purposely hurting yourself without wanting to die?" (item 1 on the Self-Injurious Thoughts and Behaviors Interview-Revised (SITBI-R); Fox et al., 2020 and item 51 on the SITBI; Nock, Holmberg, Photos, & Michel, 2007 respectively). Many individuals, however, experience their cognitions in the form of mental imagery, or seeing in the mind's eye (Pearson, Naselaris, Holmes, & Kosslyn, 2015), and many cognitive processes implicated in psychopathology take the form of mental imagery. Flashbacks associated with Post-Traumatic Stress Disorder (PTSD) (Brett & Ostroff, 1985; Brewin, Gregory, Lipton, & Burgess, 2010; Holmes, Arntz, & Smucker, 2007), mental images of feared situations or stimuli in social anxiety and specific phobias (Alfano, Beidel, & Turner, 2008; Hackmann, Clark, & McManus, 2000; Hirsch, Clark, Mathews, & Williams, 2003), appearance related mental imagery in eating disorders (Osman, Cooper, Hackmann, & Veale, 2004), and intrusive mental imagery-based memories in depression (Deeprose & Holmes, 2010; Reynolds & Brewin, 1998) are all widely established risk factors for corresponding disorders (Burnett Heyes, Lau, & Holmes, 2013a; Hagenaars & Holmes, 2012; Holmes, Blackwell, Burnett Heyes, Renner, & Raes, 2016). Only recently, however, have researchers begun to study NSSI and suicidal mental imagery, or images in the mind's eye related to harming or killing oneself.

Maladaptive cognitions that take the form of mental imagery may be even more impairing than verbal thoughts given the strong ties of mental imagery with emotion, perception, and motivation. Mental imagery is often described as an emotional amplifier. Relative to verbal thoughts, negative mental imagery elicits greater negative affect and positive mental imagery elicits greater positive affect (see Holmes & Mathews, 2010 for a review). There also is extensive evidence that mental imagery shares overlap with real perception, suggesting that mentally imagining an event may be closer to really viewing or experiencing that event relative to verbal thoughts (Ganis, Thompson, & Kosslyn, 2004; Kosslyn, Ganis, & Thompson, 2001; Mathews, Ridgeway, & Holmes, 2013; Pearson et al., 2015). Finally, mental imagery appears to have a strong motivational component. Individuals rate imagined events as more likely to occur than those that they have not imagined (Gregory, Cialdini, & Carpenter, 1982; Pham & Taylor, 1999) and mentally imagining an action may make it more likely that an individual will actually engage in that action (e.g., Jeannerod, 1995; Libby, Shaeffer, Eibach, & Slemmer, 2007; Renner, Ji, Pictet, Holmes, & Blackwell, 2017). Taken together, this would suggest that suicidal and NSSI mental imagery may result in greater negative affect, be more similar to viewing or experiencing suicidal or NSSI behavior, and may motivate engagement in suicidal or NSSI behavior to a greater extent than verbal thoughts about NSSI and suicide. If true, standard measures of NSSI and suicide risk may be missing a critical piece of suicidal and NSSI cognitions particularly associated with risk. Directly assessing suicidal and NSSI mental imagery could therefore improve risk assessment while also providing a fruitful target for intervention.

Here, we provide the first systematic review or meta-analysis synthesizing what is currently known regarding suicidal and NSSI mental imagery. We provide meta-analytic estimates for the prevalence of suicidal and NSSI mental imagery, and qualitatively review the current literature on the content and characteristics of suicidal and NSSI mental imagery, and associations between suicidal mental imagery and suicidal behavior and between NSSI mental imagery and engagement in NSSI. We also qualitatively review what is known regarding how to intervene on suicidal and NSSI mental imagery. Given the nascent nature of this literature, meta-analytic evidence of the prevalence of suicidal and NSSI mental imagery and a review of this nature will increase confidence in the notion that suicidal and NSSI mental imagery are common, impairing, and worth additional research inquiry. In addition, this comprehensive overview is critical in identifying gaps in the existing literature and key areas in which additional research and clinical innovation is needed. Finally, we offer conclusions regarding how mental imagery should be incorporated into assessment and treatment

for suicide and NSSI.

## 2. Method

This project was registered in PROSPERO (CRD42021282021) and followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

### 2.1. Search strategy and selection criteria

This review included studies that (1) assessed mental imagery of suicide or NSSI or a mental imagery-based intervention for suicide or NSSI and (2) assessed suicide or NSSI (i.e., suicidal ideation, NSSI cognitions, any type of plan or intent for suicide or NSSI, any type of suicidal or NSSI behavior). The meta-analysis component of this paper included studies that documented a prevalence estimate for suicidal or NSSI mental imagery. All relevant studies were included in the qualitative review. We identified relevant studies by systematically searching MEDLINE and PsycINFO databases from inception through December 17, 2022 (see Supplemental materials for search terms used). The search was limited to publications in English, those from peer-reviewed journals, and those that included quantitative analyses. This yielded 2236 unique articles. Each article's title and abstract was first reviewed for eligibility. If an article could not be ruled out based on the title and abstract, we examined the full text. Each article was reviewed by two of the authors independently and discrepancies were resolved by the lead author. Twenty-three articles were included in the final review (see Table 1 for study characteristics; see Fig. 1 for PRISMA diagram).

### 2.2. Data extraction

The primary data extracted were prevalence estimates of suicidal or NSSI mental imagery. Of the 23 articles included in the review, 15 reported prevalence estimates. When a single study reported multiple prevalence rates for overlapping subsamples, preference was given to prevalence estimates that maximized the number of nonoverlapping samples. When the number of nonoverlapping samples was equal, preference was given to those estimates from larger samples. For assessing potential moderators and conducting planned subanalyses, we also extracted data from the following study characteristics: mental imagery type (suicidal, NSSI); lifetime self-harm history (suicide attempt,[1] suicidal ideation, NSSI); timeframe (lifetime; at "most despairing"[2]; at time of self-harm or self-harm urge); sample age group (adolescent [defined as younger than 18 years] versus adult); and percentage of female participants in the sample. Although studies also were initially coded based on sample type (community, clinical), only one study reported a prevalence rate of self-harm mental imagery among a community sample (Ng, Di Simplicio, McManus, Kennerley, & Holmes, 2016); this estimate was therefore excluded from the meta-analytic component of this review. Twenty-two unique prevalence estimates were included in the final meta-analysis.

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[1] Defined as injuring oneself with the intent to die.

[2] This time frame was selected given that participants report on their suicidal mental imagery "when at their most despairing" on the Suicidal Cognitions Interview (SCI; Holmes et al., 2007), which is the most widely used assessment measure in the studies reviewed.

**Table 1**

Study characteristics.

| Studies evaluating prevalence, content, and characteristics of, and response to, self-harm mental imagery | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Study author(s) (year) | $N$[a] | % female[a] | Age group | (Sub)sample type[b] | Mean age | Self-harm mental imagery | | |
| | | | | | | Measure(s) | Mental imagery type | Time point |
| Brain et al. (1998) | 70 | 57.1 | Adult | – | – | Personalized NSSI scripts | NSSI | Lifetime |
| Brain et al. (2002) | 43 | 58.1 | Adult | – | 23.5 | Personalized NSSI scripts | NSSI | Lifetime |
| Cloos et al. (2020)* | 201 | 100 | Adult | NSSI | – | Two original items: Presence and frequency | NSSI | Lifetime |
| Crane et al. (2012)* | 27 | 70.4 | Adult | SI/SA | 28.0 | SCI | Suicidal | When most despairing |
| Di Simplicio et al. (2020)* | 38 | 81.6 | Adolescent/adult | NSSI | 19.5 | Self-Harm Imagery Interview | NSSI | At time of NSSI |
| El-Khoury et al. (2020)* | 25,319 | 51.3 | Adult | SI | – | One original item: Presence | Suicidal | Lifetime |
| Haines et al. (1995) | 38 | 0.0 | Adult | – | 21.7 | Personalized NSSI scripts | NSSI | Lifetime |
| Hales et al. (2011)* | 40 | 50.0 | Adult | SI | 38.3 | SCFI | Suicidal | When most despairing or suicidal |
| Hasking et al. (2018) | 393 | 76.0 | Adolescent/adult | NSSI | 20.0 | Two original items: Frequency and content | NSSI | At time of NSSI urge |
| Holaday and Brausch (2015)* | 237 | 59.0 | Adult | SI | 20.0 | SCI (modified) | Suicidal | When most despairing or suicidal |
| Holmes et al. (2007)* | 15 | 60.0 | Adult | SI | 41.1 | SCI | Suicidal | When most despairing |
| Kraus et al. (2010) | 21 | 100 | Adult | – | 25.6 | Personalized NSSI scripts | NSSI | Lifetime |
| Lawrence et al. (2021)* | 159 | 48.4 | Adolescent | SI/SA | 15.0 | SCA | Suicidal | Lifetime |
| Lawrence et al. (2021)* | 39 | 79.5 | Adult | SI | 18.9 | SCA | Suicidal | Lifetime |
| McEvoy et al. (2017)* | 154 | 79.2 | Adolescent/adult | NSSI | 20.8 | Brief-FITI-NSSI | NSSI | At time of NSSI urge |
| Ng et al. (2016)* | 162 | 71.6 | Adult | SI | 45.9 | IFES | Suicidal | Past 7 days |
| Rivlin, Fazel, Marzano, & Hawton (2013)* | 60 | 0.0 | Adult | SA | – | SCI (modified) | Suicidal | Lifetime |
| Schultebraucks et al. (2020)* | 74 | 64.9 | Adult | – | 34.2 | SCI | Suicidal | When most despairing |
| Steil et al. (2022) | 64 | – | Adolescent/adult | – | – | Questionnaire for Mental Images in Adolescents | NSSI, Suicidal | Lifetime |
| Welch et al. (2008) | 42 | 91.0 | Adult | – | 31.0 | Personalized NSSI scripts | NSSI, Suicidal | Lifetime |
| Zahl & Hawton (2004)* | 12 | 91.7 | Adolescent/adult | NSSI | 19.1 | Two original items: Presence and content | NSSI/Suicidal | At time of NSSI or NSSI urge |

| Studies assessing mental imagery-based interventions for self-harm | | | | | | |
|---|---|---|---|---|---|---|
| Study author(s) (year) | $N$[a] | % female[a] | Age group | Mean age | Intervention | Target | Intervention length |
| Di Simplicio et al. (2020) | 38 | 81.6 | Adolescent/adult | 19.5 | Functional Imagery Training | NSSI | Two sessions; smartphone app |
| Knagg et al., 2022 | 11 | 45.0 | Adult | 20.5 | Broad-Minded Affective Coping | Suicidal ideation | Six sessions |
| Schaitz et al. (2020) | 7 | 100 | Adult | 24.9 | Imagery rescripting | Reducing intrusive mental imagery | Two sessions; daily home practice |

Note. Brief-FITI-NSSI = Brief Flash-forwards Imagery and Thoughts Interview for Non-Suicidal Self-Injury; IFES = The Impact of Future Events Scale; SCA = Suicidal Cognitions Assessment; SCFI = Suicidal Cognitions and Flashforwards Interview; SCI = Suicidal Cognitions Interview; SHII = Self-Harm Imagery Interview.

[a] The sample size, age group, and percentage female presented reflect the entire study sample given that findings from many studies were included in both the meta-analysis and qualitative review. The sample size used in each analysis was retained in the relevant meta-analysis.

[b] (Sub)sample type indicates whether prevalence of self-harm mental imagery was reported among a (sub)sample of individuals with a lifetime history of suicidal ideation (SI), suicide attempts (SA), and/or NSSI.

* Study was included in the meta-analytic component of this review.

## 2.3. Analytic approach

The meta-analytic component of this review focused solely on estimating pooled prevalence rates of self-harm mental imagery (i.e., mental imagery of either NSSI or suicide). First, we documented the lifetime prevalence of any type of self-harm mental imagery.[3] Then, we conducted additional analyses to calculate separate prevalence estimates of (1) lifetime suicidal mental imagery, (2) lifetime NSSI mental imagery, any type of self-harm mental imagery among individuals with (3) lifetime histories of suicidal ideation, (4) suicide attempts, or (5) NSSI, and any type of self-harm mental imagery among (6) individuals at their most despairing point and (7) among individuals at times of self-injury or during an urge to self-injure. Finally, if significant heterogeneity in lifetime prevalence of self-harm mental imagery was observed, we submitted that prevalence estimate to moderator analysis, with age group (adolescent [defined as younger than 18 years], adult), and percentage of female participants as candidate moderators. All other findings on the content and characteristics of suicidal and NSSI mental imagery, associations between suicidal and NSSI mental imagery and suicidal and NSSI behavior, and interventions for suicidal and NSSI mental imagery were subjected to qualitative review given insufficient data published to date for meta-analytic review.

We conducted analyses using Comprehensive Meta-Analysis (version 3.3.070; Borenstein, Hedges, Higgins, & Rothstein, 2014). Heterogeneity in findings and potential publication bias were assessed for lifetime estimates of any type of self-harm mental imagery. All other analyses

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[3] A note regarding the term, "self-harm" is warranted. Where possible, we delineated suicide from NSSI. When individual studies did not separate suicide from NSSI and instead assessed mental imagery of harming oneself, or suicidal or NSSI mental imagery among samples with a self-harm history (without noting whether this was suicidal ideation/behavior or NSSI), we retained and used the term "self-harm."
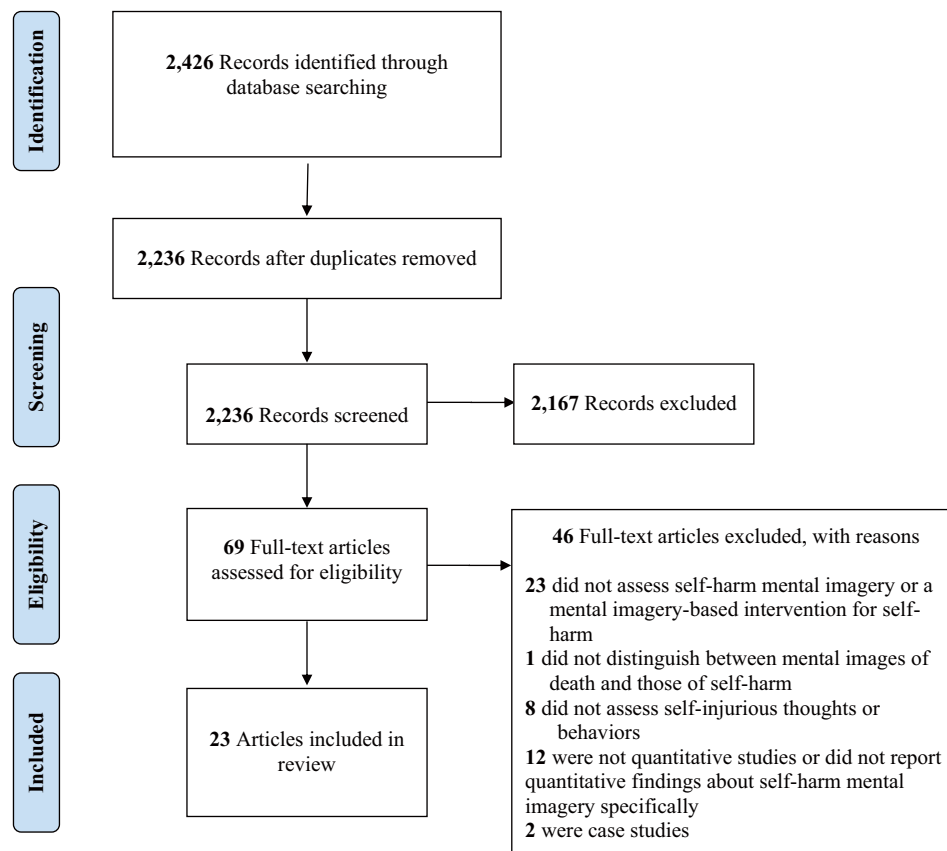
**Fig. 1.** PRISMA flow chart of literature search.

involved too few studies to meaningfully assess heterogeneity or publication bias. Heterogeneity was expected across studies due to differences in sample characteristics, measures used, and study design. The $I^2$ statistic, or the percent variance due to heterogeneity rather than sampling error (i.e., chance), was used to assess this heterogeneity. $I^2$ values near 25% indicate low heterogeneity, near 50% indicate moderate heterogeneity, and near 75% indicate substantial heterogeneity (Higgins, 2003). In addition, we calculated Duval and Tweedie trim-and-fill (Duval & Tweedie, 2000) and Egger's regression intercept (Egger, Smith, Schneider, & Minder, 1997) to test for potential publication bias inflating estimates of pooled prevalence rates. Duval and Tweedie's trim-and-fill analysis estimates the number of studies potentially missing from the meta-analysis due to publication bias and what impact these studies might have had on prevalence estimates. An adjusted prevalence estimate and confidence interval are also generated based on inclusion of these missing studies. This was complemented by evaluating the asymmetry of a funnel plot of the standard error of each study included in the meta-analysis with the study's reported prevalence rate. Egger's regression intercept was also used to estimate possible publication bias using linear regression to assess study prevalence rates compared to their standard error.

## 3. Results

### 3.1. Meta-analytic findings

First, the pooled lifetime prevalence rates of self-harm mental imagery, or mental images of either NSSI or suicide, were examined in clinical samples[4] (see Table 2). Overall, 76.88% of individuals reported self-harm mental imagery. When calculated separately, 73.56% of individuals reported suicidal mental imagery and 84.33% reported NSSI mental imagery. Prevalence of self-harm mental imagery did not significantly differ among individuals with a lifetime history of suicide attempts (74.50%), suicidal ideation (72.17%), or NSSI (83.32%) (between individuals with a lifetime history of suicide attempts vs suicidal ideation: $p = .87$; suicide attempts vs NSSI: $p = .47$; suicidal ideation vs NSSI: $p = .13$). Rates of self-harm mental imagery were high at times when individuals were "at their most despairing" (91.40%) and at times when individuals had the urge to self-injure or when individuals actually engaged in self-harm behaviors (82.90%).

Moderator analyses for lifetime self-harm mental imagery were warranted given that heterogeneity was high ($I^2 = 92.19$, $p < .001$). Moderator analyses were conducted for age group (adolescent, adult) and percent female (see Table 3). Age group moderated prevalence estimates such that prevalence rates of self-harm mental imagery were significantly higher for adults (79.76%) compared with adolescents (37.75%), $p < .001$. Percent females in the sample was not a significant moderator of prevalence estimates ($p = .56$).

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[4] As noted previously, only one study reported a prevalence rate for self-harm mental imagery among a community sample (Ng et al., 2016); this prevalence rate was excluded such that all pooled prevalence rates reflect rates in clinical samples.

**Table 2**
Prevalence rates of self-harm mental imagery.

| | $k$ | $N$ | Prevalence estimates | |
|---|---|---|---|---|
| | | | % | 95% CI |
| **Mental Imagery Type** | | | | |
| Self-harm overall | 22 | 2270 | 76.88% | 68.08%–83.83% |
| Suicidal | 17 | 1736 | 73.56% | 62.41%–82.33% |
| NSSI | 4 | 522 | 84.33% | 72.83%–91.53% |
| **Individuals with a lifetime history of** | | | | |
| Suicide attempts | 3 | 112 | 74.50% | 44.36%–91.46% |
| Suicidal ideation | 10 | 1576 | 72.17% | 59.60%–82.01% |
| NSSI | 5 | 534 | 83.32% | 72.75%–90.33% |
| **Sample Age Group** | | | | |
| Adolescents | 2 | 159 | 37.75% | 15.16%–67.30% |
| Adults | 16 | 1778 | 79.76% | 69.83%–87.03% |
| **Time Point** | | | | |
| At "most despairing point" | 10 | 240 | 91.40% | 80.79%–96.41% |
| At time of self-injury or self-injury urge | 5 | 344 | 82.90% | 70.42%–90.80% |

Note. CI = confidence interval; $k$ = number of unique effects; $N$ = total number of participants included in pooled analyses. All samples were clinical samples.

**Table 3**
Moderator analyses for prevalence of self-harm mental imagery.

| Moderator | $k$ | $N$ | Prevalence analyses | | | | |
|---|---|---|---|---|---|---|---|
| | | | $b$ | SE | % | 95% CI | $p$ |
| Age Group | 18 | 1937 | | | 64.69% | 62.34%–66.96% | <0.001 |
| % Female | 15 | 1871 | 0.005 | 0.009 | | | 0.56 |

Note. CI = confidence interval; $k$ = number of unique effects; $N$ = total number of subjects included in pooled analyses.

Analyses of publication bias were conducted for lifetime prevalence of self-harm mental imagery; little evidence of bias was found. Egger's regression test was not significant (intercept = 1.74, $p$ = .12). Duval and Tweedie's trim-and-fill method yielded modest declines in overall prevalence rates of self-harm mental imagery when considering potentially missing studies due to publication bias (adjusted prevalence = 70.80%, 95% CI = 61.22%–78.83%). There was only modest evidence of asymmetry in the corresponding funnel plot, suggesting limited publication bias (Fig. 2).

*3.2. Qualitative review*

Additional findings spoke to the prevalence of suicidal and NSSI mental imagery but were not included in the meta-analytic portion due to insufficient number of studies for quantitative synthesis. After these studies are qualitatively reviewed, we review what is currently known regarding the content and characteristics of suicidal and NSSI mental imagery, links between suicidal and NSSI mental imagery and suicidal and NSSI behavior, and interventions to address suicide and NSSI using mental imagery. In each section, we discuss suicidal mental imagery and then NSSI mental imagery.

*3.2.1. Prevalence of self-harm mental imagery*

First, El-Khoury et al. (2020) evaluated clinical and demographic differences in the prevalence of suicidal mental imagery among adults who completed the French Health Barometer, a general population phone survey. Factors associated with higher odds of suicidal mental imagery included having a lower household income, not living with a partner, sexual minoritized status, history of chronic illness, sexual victimization, and having lost a parent or loved one. Second, Steil, Fischer, Gutermann, and Rosner (2022) retrospectively coded responses as self-harm mental imagery in adolescents with a history of PTSD, who reported experiencing mental imagery related to injury or death. 17.2% of responses were coded as being about hurting oneself and 10.3% of responses were coded as being about killing themselves, although this study sample size was small ($N$ = 32).

Only one study compared the prevalence of NSSI mental imagery and NSSI verbal thoughts. McEvoy, Hayes, Hasking, and Rees (2017) asked undergraduates with a history of NSSI how often they thought in verbal thoughts and mental images during NSSI urges that did or did not result in NSSI engagement. Participants reported significantly more frequent verbal thoughts compared to mental images during NSSI urges, though the vast majority of individuals reported at least some verbal thoughts (92%) and mental images (93%) when they acted on these NSSI urges.

The above research suggests that clinical samples commonly experience suicidal and NSSI mental imagery. However, all estimates reflect retrospective self-report of mental imagery. Only one study has tested predictors of suicidal mental imagery (El-Khoury et al., 2020) and this study was conducted with a non-clinical general population sample. It therefore remains unknown what risk factors are associated with higher odds of suicidal mental imagery among more acutely at-risk individuals.

*3.2.2. Content and characteristics of self-harm mental imagery*

*3.2.2.1. Suicidal mental imagery.* Commonly reported themes of suicidal mental imagery included planning or preparing to make a future suicide attempt (Crane, Shah, Barnhofer, & Holmes, 2012; Haines, Williams, Brain, & Wilson, 1995; Holmes et al., 2007; Ng et al., 2016) or the things one would escape from by attempting suicide (Haines et al., 1995; Holmes et al., 2007). Still other suicidal mental imagery is more passive, described as mental images of what might happen to you or other people if you died (Crane et al., 2012; Haines et al., 1995; Holmes et al., 2007; Ng et al., 2016). Holmes et al. (2007) compared content of suicidal mental images and suicidal verbal thoughts, finding that participants reported significantly more mental images than verbal thoughts for "What might happen if you died" and "Planning/preparing to make a (new) suicide attempt or harm yourself." These findings suggest that although the content of suicidal mental imagery does appear to vary, suicidal mental images tend to be episodic, future oriented, and often describe potential engagement in future suicidal behavior. It is important to note that most information on themes of suicidal mental imagery is derived from individuals reporting on the content of their "most significant image" on the SCI (Holmes et al., 2007); the content of other mental images or perhaps the mental images that appear in mind most often remains unknown.

Regarding characteristics of suicidal mental imagery, ratings of vividness and realism are consistently high. Among undergraduates who had experienced suicidal mental imagery, 69% rated suicidal mental imagery as at least moderately vivid with rates rising to 100% among undergraduates with a history of suicide attempt (Holaday & Brausch, 2015). Similarly, 67% of adults with a history of suicidal thoughts or behaviors rated their suicidal mental imagery as at least moderately realistic (Holmes et al., 2007). In the only study to date to compare the vividness or realism of suicidal mental images versus verbal thoughts, ratings were similar (Schultebraucks, Duesenberg, Di Simplicio, Holmes, & Roepke, 2020).

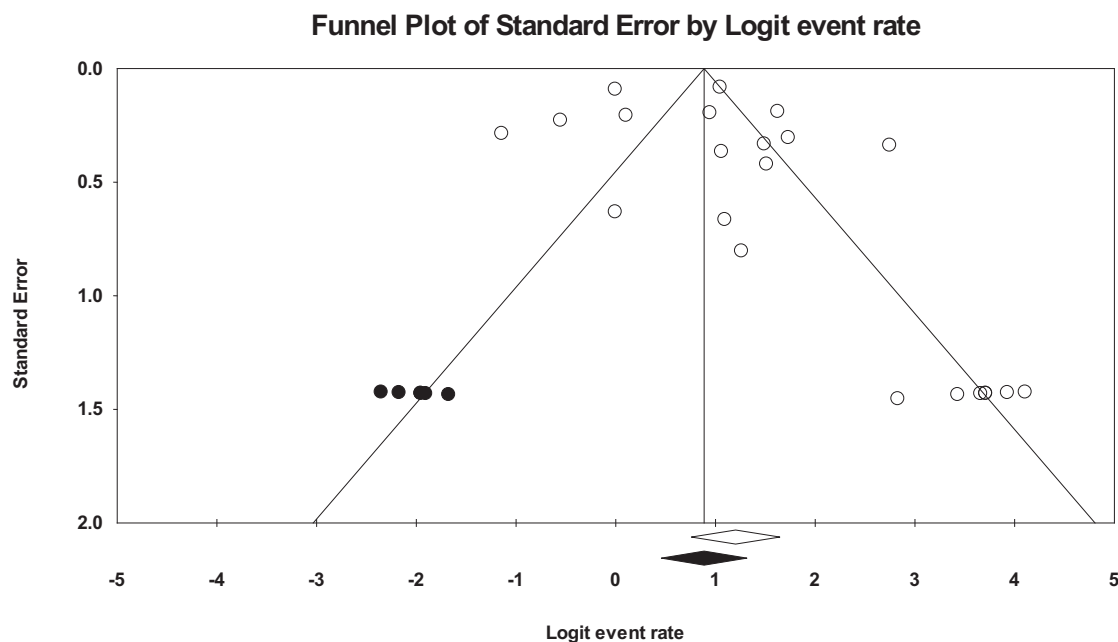Along with being vivid and realistic, suicidal mental imagery can be

## Funnel Plot of Standard Error by Logit event rate



**Fig. 2.** Funnel plot for prevalence of self-harm mental imagery.

Note. Funnel plots for prevalence rates in the meta-analysis. The vertical line indicates the weighted mean prevalence. Open circles represent observed prevalence rates for actual studies. Closed circles represent imputed prevalence estimates for studies believed to be missing due to publication bias. The clear diamond reflects the unadjusted weighted mean prevalence rate. The black diamond reflects the weighted mean prevalence rate after adjusting for publication bias. Only modest asymmetry was present in the funnel plot and Egger's regression intercept test was not statistically significant (2-tailed $p = .12$).

experienced either as distressing or as comforting. Suicidal mental imagery is consistently rated as at least moderately distressing (Hales, Deeprose, Goodwin, & Holmes, 2011; Holmes et al., 2007) and as at least moderately comforting (Holmes et al., 2007) or positive (Ng et al., 2016). As one example, among adults in Hong Kong who reported suicidal mental imagery, 81.3% rated their suicidal mental imagery about the aftermath of imagined suicide as positive (versus 18.7% who rated them as negative) and 35.7% rated their suicidal mental imagery about engaging in future suicidal behavior as positive (versus 64.3% who rated them as negative; Ng et al., 2016).

Finally, studies have assessed the extent to which suicidal mental imagery is preoccupying. Two-thirds of adults with a history of suicidal thoughts or behaviors reported that during a crisis, they were preoccupied with their suicidal mental imagery at least half the time (Holmes et al., 2007). This is supported by the finding that adults with a lifetime history of suicide attempt spent on average, half of their time mentally imagining suicide when most "depressed and despairing" (Crane et al., 2012).

Characteristics of suicidal mental imagery may also vary depending on an individual's type or severity of mental health symptoms. Relative to adults with unipolar depression, adults with borderline personality disorder (BPD) and comorbid PTSD reported more vivid suicidal mental imagery (Schultebraucks et al., 2020), and adults with bipolar depression reported that they were more preoccupied with their suicidal mental imagery and that they found their suicidal mental imagery to be more compelling (Hales et al., 2011). No studies, however, have evaluated differences in characteristics of suicidal mental imagery within specific demographic groups or based on individuals' identities. In sum, suicidal mental imagery is commonly described as vivid, realistic, and can be both distressing and comforting. Individuals also appear to spend a considerable amount of time mentally imagining suicide, especially during times of high distress.

*3.2.2.2. NSSI mental imagery.* Few studies have evaluated the content or characteristics of NSSI mental imagery. NSSI mental images are most often described as depicting engagement in NSSI or a NSSI-related object

such as a razorblade (Cloos, Di Simplicio, Hammerle, & Steil, 2020). Regarding characteristics, McEvoy et al. (2017) found that on days in which individuals acted on urges to self-injure, NSSI mental images were rated as less distressing than NSSI verbal thoughts; on days in which individuals did not act on their urges to self-injure, NSSI mental images were rated as more distressing than NSSI verbal thoughts. Mental images and verbal thoughts about NSSI did not differ in ratings of how (dis) comforting they were, regardless of whether individuals acted on urges to self-injure. This preliminary research suggests that individuals do mentally imagine NSSI engagement, though additional research is needed to further understand characteristics of NSSI mental imagery, both alone and in comparison to verbal thoughts about NSSI.

*3.2.3. Response to experimentally induced self-harm mental imagery*

Only one study (Welch, Linehan, Sylvers, Chittams, & Rizvi, 2008) has evaluated individuals' response to experimentally induced mental imagery of suicide while several experimental studies have examined physiological and affective responses to NSSI mental imagery. In each study, participants were interviewed about their experiences of suicide or NSSI. Personalized scripts were developed describing an act of NSSI (or in the case of Welch et al., 2008, a suicide attempt) and what happened before and after. Participants were instructed to mentally imagine the self-harm event as the personalized scripts were played. Responses were compared for imagining a suicide attempt or NSSI versus control scenarios, which included accidental injury or neutral events.

When evaluating individuals' response to mentally imagining a past suicide attempt, Welch et al. (2008) did not find support for escape conditioning as negative emotion and physiology generally did not change from before, to during, to after the imagined suicide attempt. This work clearly requires replication given that it is the only study to date to evaluate response to experimentally induced suicidal mental imagery. Studies did provide evidence for escape conditioning when evaluating mentally imagined NSSI, however. Physiological arousal decreased during NSSI mental imagery and remained low post-NSSI mental imagery, whereas the opposite pattern was observed during

imagined control scenarios (Brain, Haines, & Williams, 1998; Brain, Haines, & Williams, 2002; Haines et al., 1995).[5] Subjective affect ratings followed a similar pattern with decreases in negative affect reported during NSSI mental imagery (Brain et al., 1998; Brain et al., 2002). These findings do not appear to differ depending on whether individuals frequently or infrequently engaged in NSSI (Brain et al., 2002) or whether individuals engaged in NSSI currently or only in the past (Brain et al., 1998). Results suggest that similar to actually engaging in NSSI, mentally imagining NSSI may have an emotional and physiological regulation function.

In relation to neural response to NSSI mental imagery, only one neuroimaging study has been conducted (Kraus et al., 2010). Female adults with and without a history of BPD and self-harm were instructed to imagine the circumstances around the actual act of cutting using standardized scripts during a functional magnetic resonance imaging scan. Mentally imagining cutting oneself was associated with reduced activation in the right mid-cingulate and the left fusiform gyrus, regions linked with emotion regulation and face recognition, respectively. However, these findings require cautious interpretation prior to further replication due to the study's small sample size ($N = 21$) and the large samples often required in imaging studies to produce reliable results (Marek et al., 2022).

### 3.2.4. Links between self-harm mental imagery and self-harm behavior

*3.2.4.1. Suicidal mental imagery.* A key clinical question is whether mentally imagining suicide is associated with increased risk for suicidal behavior. Emerging research suggests that the answer to this question may be yes. In both college students (Lawrence, Nesi, & Schwartz-Mette, 2022) and psychiatrically hospitalized adolescents (Lawrence et al., 2021), having mentally imagined suicide was associated with a higher likelihood of having made a lifetime suicide attempt even after controlling for verbal thoughts about suicide and other relevant clinical and demographic characteristics. Suicidal mental imagery appears to be even more impairing when experienced as distressing. The more distressing and less comforting suicidal mental imagery was rated, the higher number of lifetime suicide attempts adults with major depressive disorder or BPD had made (Schultebraucks et al., 2020). It is worth noting, however, that all studies that have evaluated the association between suicidal mental imagery and suicidal behavior have been cross-sectional or retrospective.

Additional studies have examined suicidal mental imagery in relation to severity of suicidal ideation. Although these studies did not assess suicidal behavior directly, findings may speak to risk for suicidal behavior given that more intense or frequent suicidal ideation is associated with higher risk for suicidal behavior (Ati, Paraswati, & Windarwati, 2021; Oquendo, Currier, & Mann, 2006; Rossom et al., 2017). Greater suicidal mental imagery has consistently been shown to be positively associated with more severe suicidal ideation (Lawrence et al., 2022; Ng et al., 2016) especially when suicidal mental imagery is rated as more realistic, vivid, comforting/positive, preoccupying, or action-provoking (Crane et al., 2012; Holaday & Brausch, 2015; Holmes et al., 2007; Ng et al., 2016; Schultebraucks et al., 2020). This latter finding is particularly concerning given that mental imagery is found to be more similar to real perception and to amplify both negative and positive affect to a greater degree than verbal thoughts (Ganis et al., 2004; Holmes & Mathews, 2010; Kosslyn et al., 2001; Mathews et al., 2013; Pearson et al., 2015).

*3.2.4.2. NSSI mental imagery.* Results are notably mixed when it comes to whether NSSI mental imagery is associated with higher NSSI engagement. One study (Cloos et al., 2020) found NSSI mental imagery to be associated with greater engagement in NSSI. Higher lifetime frequency of NSSI mental imagery was associated with greater lifetime NSSI and daily NSSI mental imagery was associated with higher likelihood of daily NSSI. In fact, 88.24% of the time individuals engaged in NSSI they had experienced a NSSI mental image within the two hours prior. Counter to these results, however, Hasking, Di Simplicio, McEvoy, and Rees (2018) did not find a significant association between frequency of NSSI mental images and frequency of NSSI in their sample of undergraduate students with a lifetime history of NSSI. Potentially helping to resolve these discrepant findings, additional research has evaluated whether specific characteristics of NSSI mental images impact whether NSSI mental imagery is associated with engagement in NSSI. NSSI mental images that were perceived to encourage rather than discourage NSSI behavior (McEvoy et al., 2017) and greater attentiveness to NSSI mental imagery (Di Simplicio et al., 2020) were associated with higher risk for NSSI, whereas no significant differences were found in how comforting, compelling, vivid, or controllable NSSI mental images were on days where individuals did or did not engage in NSSI (Cloos et al., 2020).

### 3.2.5. Mental imagery-based interventions for self-harm

One identified study tested an imagery-based intervention for suicidal ideation (Knagg, Pratt, Taylor, & Palmier-Claus, 2022) though no intervention specifically targeting suicidal mental imagery has been evaluated. Knagg et al. (2022) examined whether a six-session intervention that fosters mental imagery of positive autobiographical memories (i.e., Broad-Minded Affective Coping; Johnson, Gooding, Wood, Fair, & Tarrier, 2013; Tarrier, 2010) reduces suicidal ideation among college students. Scores on the Beck Scale for Suicide Ideation (Beck & Steer, 1991) significantly decreased from pre- to post-intervention ($d = -1.22$) and were maintained from pre-intervention to 12-week follow-up ($d = -1.25$). The impact of the intervention on suicidal ideation was only evaluated in 11 college students, however, and changes in suicidal behavior were not tested.

In regards to mental imagery-based interventions for NSSI, two studies have been conducted, but again, neither was sufficiently powered to evaluate efficacy. Di Simplicio et al. (2020) conducted a preliminary trial evaluating the feasibility of Functional Imagery Training (FIT; Kavanagh, Andrade, May, & Connor, 2014) in reducing self-harm behavior. FIT integrates mental imagery generation with motivational interviewing (Miller & Black, 2020) to help individuals develop more adaptive behavioral alternatives to self-harm. Individuals who had engaged in self-harm in the past three months were randomly allocated to FIT or a waitlist control condition. No significant differences between the two conditions were found and self-harm frequency decreased and perceived efficacy at controlling self-harm increased over time in both conditions. Individuals who initially reported greater self-harm mental imagery and greater negative affect following self-harm mental imagery did benefit most from FIT. Although potentially promising, FIT remains to be further validated as the preliminary trial ($N = 38$) was not powered to establish the actual efficacy of FIT and did not include an active comparison condition.

Schaitz, Kroener, Maier, Connemann, and Sosic-Vasic (2020) conducted an exploratory imagery rescripting intervention study that specifically targeted NSSI mental imagery. Female participants with a history of self-harm engaged in a two-session imagery rescripting intervention. Specifically, individuals identified a distressing NSSI mental image (e.g. cutting) and reimagined the scenario, instead imagining a more adaptive regulatory behavior (e.g. seeking support from a family member). Results from this exploratory study indicated good tolerance and self-reported efficacy of the imagery rescripting intervention on emotion regulation and NSSI behavior reduction. However, due to the small sample size ($N = 7$) and the lack of a control condition, the ability to assess changes from pre- to post-treatment were constrained. In addition, changes in NSSI mental imagery were not

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[5] But see also Welch et al. (2008) in which decreases in physiological arousal were not observed until the period following NSSI mental imagery.

assessed. As such, the efficacy of the intervention remains unknown.

## 4. Discussion

The present systematic and meta-analytic review is the first to evaluate and summarize the empirical body of literature on suicidal and NSSI mental imagery. The goal of this review was to establish meta-analytic estimates of the prevalence of suicidal and NSSI mental imagery. It further aimed to qualitatively review the literature on the content and characteristics of suicidal and NSSI mental imagery and the associations between suicidal and NSSI mental imagery and risk for suicidal and NSSI behaviors, as well as discuss the literature on interventions for suicidal and NSSI mental imagery.

Our meta-analytic review finds self-harm mental imagery to be highly prevalent. Even though the vast majority of research on suicidal and NSSI cognitions has focused on verbal thoughts and that existing gold standard measures of suicide and NSSI risk exclusively assess verbal thoughts of self-harm, over three-quarters of individuals from clinical samples reported that they had experienced mental imagery related to self-harm. Prevalence rates were consistently high regardless of whether studies reported on mental images of suicide or NSSI and whether rates were from samples with a history of suicide attempts, suicidal ideation, or NSSI. However, rates of self-harm mental imagery did appear to be highest when individuals were experiencing high levels of distress, for example, when individuals actually engaged in self-harm behaviors. Importantly, these prevalence rates were pulled from clinical samples, and diverse clinical presentations at that; it therefore remains unknown what the prevalence of self-harm mental imagery is in the general population or among specific clinical (e.g., among individuals with depression) or demographic (e.g., among individuals of diverse gender identities) groups. In addition, few studies directly compared rates of mental imagery and verbal thoughts about suicide and NSSI. Findings from the few studies that have, are mixed. One study found that self-harm mental imagery may be more common than suicidal verbal thoughts (Lawrence et al., 2022) while two others found the opposite (Lawrence et al., 2021; McEvoy et al., 2017), though all three studies found that most individuals report both mental imagery and verbal thoughts about self-harm.

Regarding what we know about the content and characteristics of self-harm mental imagery, self-harm mental imagery often depicts actual self-harm engagement or means of self-harm engagement (Cloos et al., 2020; Crane et al., 2012; Haines et al., 1995; Holmes et al., 2007; Ng et al., 2016) and is perceived to be highly vivid, realistic, and preoccupying (Crane et al., 2012; Holaday & Brausch, 2015; Holmes et al., 2007). Furthermore, results indicate that self-harm mental imagery may be especially vivid, realistic, and preoccupying when mental health distress is high (Hales et al., 2011; Schultebraucks et al., 2020). It makes sense that individuals find self-harm mental imagery to be intense and detailed if individuals are imagining actually engaging in self-harm. Mental imagery shares largely overlapping neural substrates with perception (Ganis et al., 2004; Pearson, 2019); as such, mental imagining self-harm may be experienced similarly to past experiences of actually engaging in self-harm or rehearsal of future engagement in self-harm.

Although the vast majority of individuals rated their self-harm mental imagery as at least moderately vivid, realistic, and preoccupying, there were mixed findings regarding whether individuals rated self-harm mental imagery as more distressing and negative or as more comforting and positive (Hales et al., 2011; Holmes et al., 2007; Ng et al., 2016). This may reflect a risk or protective factor. On the one hand, individuals who rate their self-harm mental imagery as more distressing may be more likely to avoid self-harm behavior as they have learned that self-harm is associated with increased negative emotion. On the other hand, the increase in distress experienced when mentally imagining self-harm could lead individuals to more immediately need a means of regulating distress, which could lead to self-harm behavior.

Similarly, experiencing self-harm mental imagery as comforting could reinforce self-harm as an emotion regulation strategy and lead individuals to habituate to pain associated with self-harm, or could lower distress to the extent that self-harm behavior is not needed to regulate distress.

A next step may be to decipher whether there are within- or between-person differences in how comforting or distressing NSSI and suicidal mental imagery is. For example, it may be that some individuals experience this mental imagery as comforting and others as distressing, which may put different people at risk for self-harm behavior. Alternatively, it could be that there are specific mental images or certain moments of time in which mental imagery is more or less comforting and more or less distressing for a given individual, which also may impact their proximal risk for self-harm behavior. This line of inquiry is especially important given what is currently known regarding functions of NSSI. If some individuals engage in self-harm as a means of emotion regulation (Andover & Morris, 2014), for instance, NSSI mental imagery could either serve a similar regulatory function (increasing comfort) or could increase the need for regulation (increasing distress). Interventions could also then be tailored based on whether individuals experience their mental images of suicide and NSSI as more comforting or distressing.

Regarding potential differences in content and characteristics of suicidal and NSSI mental imagery and verbal thought, few studies have directly compared the two. Mental imagery is, however, consistently rated as more emotionally laden and "more real" than verbal thoughts in other contexts (Holmes & Mathews, 2010). This suggests that suicidal and NSSI mental imagery may be even more maladaptive or perhaps more strongly linked with risk for self-harm behavior than suicidal and NSSI verbal thoughts in part because they are more vivid, realistic, and linked with a stronger emotional response. There is some evidence that more vivid and realistic mental imagery is associated with increased risk for maladaptive behavior in related fields. More vivid mental imagery is associated with higher intensity substance use (e.g., May, Andrade, Panabokke, & Kavanagh, 2004) and food (e.g., Harvey, Kemps, & Tiggemann, 2005; Tiggemann & Kemps, 2005) cravings and perhaps even consumption (Zorjan & Schienle, 2022). This would need to be studied in relation to self-harm directly, but it is possible that suicidal and NSSI mental imagery is associated with especially high risk for self-harm behavior when it is perceived as vivid and realistic.

The reviewed empirical studies suggest that suicidal mental imagery may in fact be associated with a higher likelihood of suicidal behavior (Schultebraucks et al., 2020), even when controlling for verbal thoughts about suicide (Lawrence et al., 2021; Lawrence et al., 2022). Findings are more mixed regarding whether experiencing NSSI mental imagery is associated with increased risk for NSSI. Although Cloos et al. (2020) found that mentally imagining NSSI may be associated with engagement in NSSI, Hasking et al. (2018) did not find a significant association.

Some limited research has attempted to identify potential mechanisms linking self-harm mental imagery with self-harm behavior. Experimental studies identified within this systematic review, however, were largely limited to those focused on NSSI mental imagery. Findings from experimental studies investigating NSSI mental imagery suggest at least partial support for escape conditioning in which imagining oneself engaging in NSSI behavior lowers both physiological arousal and subjective negative affect (Brain et al., 1998; Brain et al., 2002; Haines et al., 1995). As such, it is possible that naturally occurring NSSI mental imagery also serves these functions, potentially negatively reinforcing NSSI through emotion regulation. However, whether NSSI mental imagery increases or decreases the likelihood of NSSI behavior remains unknown due to a lack of prospective assessments at the timescale in which NSSI risk unfolds (i.e., real-time ecological momentary assessment). It is possible that by achieving the desired emotional regulatory effects through mentally imagining NSSI behavior, some may observe reductions in the urge to engage in NSSI behavior. Yet, it also is possible that imagining NSSI behavior serves to make more salient the desired

emotional outcomes resulting from NSSI behavior, thereby increasing approach motivation. Indeed, some evidence for this causal relationship is found in the craving literature, where imagining consumption tends to increase desire for, rather than satiate desire for, actual consumption (Devos, Pandelaere, & Kerckhove, 2022). Although the reviewed experimental studies were conducted to test reinforcement theories of NSSI behavior itself, by using mentally imagined NSSI as proxy, findings provide insight into the physiological correlates of NSSI mental imagery. Future studies are needed to replicate and extend these findings and to more fully investigate experimentally induced suicidal mental imagery.

When interpreting the association between self-harm mental imagery and engagement in self-harm behavior, and the results of the extant experimental studies, it is useful to consider existing self-harm theories. Joiner's concept of acquired capability for suicide, within the interpersonal theory of suicide (Joiner, 2007; Van Orden et al., 2010), is that acquired capability, or habituation to the pain and fear associated with suicide, is necessary for engagement in suicidal behavior. One way that individuals may effectively habituate to this pain and fear may be through repeated exposure to suicidal mental imagery. In line with this conjecture, mental imagery results in habituation in other contexts (e.g., imaginal exposure to treat anxiety disorders; Maples-Keller & Rauch, 2020). Studies experimentally inducing NSSI mental imagery generally also found decreases in negative affect and physiological arousal as you would expect during habituation. It is important to note, however, in the only study to directly evaluate the relation between suicidal mental imagery and acquired capability for suicide, the association was not significant (Holaday & Brausch, 2015). Given evidence suggesting that the measure Holaday and Brausch (2015) used to assess acquired capability for suicide (i.e., the Acquired Capability for Suicide Scale) may have poor psychometric properties (Rogers, Bauer, Gai, Duffy, & Joiner, 2021), and that this finding has yet to be replicated, future prospective research using alternative measures of acquired capability are needed to evaluate this hypothesis more thoroughly.

A second relevant theory of suicide is the integrated motivational-volitional theory of suicidal behavior (IMV; O'Connor & Kirtley, 2018). According to the IMV model, mental imagery may serve as a 'volitional moderator' or factor that increases the likelihood of transitioning from suicidal ideation to suicidal behavior. O'Connor and Kirtley posit that this is due to mental imagery serving as a form of cognitive rehearsal for the behavior. Indeed, the concept that mentally imagining an action increases the likelihood of engaging in that action has been demonstrated in other fields (e.g., Ji, Geiles, & Saulsman, 2021; Koehler, 1991; Libby et al., 2007). For example, mentally imagining engaging in behavioral activation has been shown to be associated with a higher likelihood of actual engagement in behavioral activation (e.g., Ji et al., 2021; Renner et al., 2017). This may be because, as noted above, mental imagery is similar to real perception. Mentally imagining self-harm thus may act as mental rehearsal, preparing individuals for engagement in self-harm. However, this remains to be tested experimentally.

### 4.1. Limitations

There are several notable limitations to the reviewed body of literature. First, our findings indicate that most empirical studies reviewed in the present meta-analysis and systematic review are cross-sectional. As a result, whether the experience of self-harm mental imagery actively influences prospective risk for suicide and NSSI remains unknown. It is possible that individuals with a history of self-harm mentally imagine self-harm they previously engaged in or that individuals with a history of self-harm are more likely to mentally imagine future self-harm given their higher clinical severity.

Second, the majority of studies reviewed relied exclusively on self-report of self-harm mental imagery. One could argue that self-report may be the ideal mode of assessment given that mental images are cognitions. At the very least, it would be beneficial to assess self-harm

mental imagery in individuals' real lives and in the moments these mental images occur using methods such as ecological momentary assessment (EMA). EMA would allow for more frequent assessment. This may be especially important given recent findings regarding the time-scale of suicidal cognitions (Coppersmith et al., 2022). Using EMA also would help us to identify whether people experience both visual and verbal content during individual cognitions about suicide or NSSI or whether suicidal and NSSI mental images and verbal thoughts are distinct mental events. How changes in the degree of mental imagery and verbal thought during NSSI and suicidal cognitions are associated with changes in risk of NSSI and suicidal behavior could further inform intervention development and timing of delivery. Those studies that did not rely on self-report used a variety of methods including personalized self-harm mental imagery scripts (Brain et al., 1998; Brain et al., 2002; Haines et al., 1995; Welch et al., 2008). Studies better integrating self-reported suicidal and NSSI mental imagery with response to experimental induction of suicidal and NSSI mental imagery could help clarify why these mental images may be especially strongly linked with suicidal behavior while also informing the reliability and validity of self-report assessment in this context. In addition, even those studies that used experimental induction of suicidal and NSSI mental imagery relied on self-reported mental imagery during the induction. Evaluating more objective markers of mental imagery, such as visual cortex activation during suicidal or NSSI cognitions, could substantiate reports of mental imagery and increase confidence in results.

Third, few studies directly compared suicidal and NSSI mental imagery to suicidal and NSSI verbal thoughts, limiting our understanding of their unique roles in risk assessment and how they may differentially influence risk trajectories. Although initial research conducted by Lawrence et al. (2021, 2022) indicates that suicidal mental imagery may predict suicide risk over and above suicidal verbal thoughts, these studies was cross-sectional in design, preventing temporal conclusions from being drawn. Fourth, there is limited research to shed light on developmental differences in the prevalence and content of self-harm mental imagery. Although the present meta-analytic findings suggest there may be developmental differences in prevalence, we identified only one study with a purely adolescent sample (Lawrence et al., 2021) and none on preadolescent children. Finally, research is needed evaluating relations between mental images of suicide and NSSI and the tendency to experience other psychopathology-relevant mental imagery (e.g., flashbacks in PTSD) or even mental imagery in daily life. Clarifying whether some individuals are prone to intrusive or problematic mental imagery more broadly or whether some individuals start to experience mental imagery only as their risk for suicide and NSSI heightens will inform both prevention and intervention efforts.

### 4.2. Clinical applications

#### 4.2.1. Assessment

The present findings highlight the high prevalence of suicidal and NSSI mental imagery and evidence the link between self-harm mental imagery and self-harm behavior, which is perhaps even stronger than the association between verbal thoughts and self-harm (Lawrence et al., 2021; Lawrence et al., 2022). Compared to the vast literature on suicidal ideation and even thoughts of NSSI, the literature on suicidal and NSSI mental imagery is far more modest. This is striking given the current findings, which strongly give reason for concern when individuals report mental images of suicide or NSSI. Unfortunately, extant broadly used suicide and NSSI risk measures also do not directly ask about self-harm mental imagery. This is especially problematic, as previous findings indicate that many individuals who deny verbal suicidal thoughts endorse suicidal mental imagery when specifically asked. For example, 50% of a sample of adults with a history of depression who denied verbal suicidal ideation during a clinical interview endorsed mental imagery related to death and suicide (Crane et al., 2012). We may be missing these individuals who experience only suicidal or NSSI mental imagery

in existing risk assessments, a subgroup who may be at especially high risk. To comprehensively and accurately assess self-harm risk, we need to incorporate the assessment of self-harm mental imagery into existing measures of risk and to subsequently validate these measures. Although preliminary evidence indicates that the Suicidal Cognitions and Flash-forwards Interview (Hales et al., 2011) may be a useful starting point, studies evaluating its predictive validity are essential before adaptation or implementation. Furthermore, this interview was developed for adults and is specific to suicidal cognitions and thus requires extension to pediatric populations and to NSSI.

### 4.2.2. Intervention

Given the high prevalence of suicidal and NSSI mental imagery and the observed links between self-harm mental imagery and self-harm behavior, researchers have recently begun investigating how mental imagery may be used in interventions to reduce risk. Our search found very few studies that evaluated mental imagery-based interventions for NSSI and suicide or interventions directly targeting NSSI and suicidal mental imagery. The three studies that were identified evaluated whether mental imagery can be used to reduce suicidal ideation (Knagg et al., 2022) and NSSI risk (Di Simplicio et al., 2020; Schaitz et al., 2020). Although we cannot draw meaningful conclusions about efficacy from these three studies given their inadequate power due to small sample sizes, the studies do offer initial evidence that interventions aimed at employing mental imagery for rescripting purposes may have promise. Future research with larger samples is needed to investigate whether these interventions are in fact effective, to develop potential alternative mental imagery-based interventions that more directly address self-harm mental imagery, and to test existing mental imagery-based interventions from other domains that may have promise in reducing self-harm and suicide risk. For example, teaching mental imagery-based Dialectical Behavioral Therapy (DBT) skills (e.g., distraction, mindfulness, self-soothing), and using mental imagery-based tools to increase the salience of Safety Planning (Stanley & Brown, 2012) and to imagine a positive future (e.g., Williams, Blackwell, Mackenzie, Holmes, & Andrews, 2013) could hold promise in ultimately reducing risk for suicidal and NSSI behavior.

### Funding

### Declaration of Competing Interest

None.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cpr.2023.102302.

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