

# Impulsivity and nonsuicidal self-injury: A review and meta-analysis



Chloe A. Hamza <sup>\*</sup>, Teena Willoughby, Taylor Heffer

Department of Psychology, Brock University, 500 Glenridge Avenue, St. Catharines, Ontario L2S 3A1, Canada

## HIGHLIGHTS

- The link between impulsivity and NSSI is examined.
- Negative urgency is associated with NSSI.
- Behavioral measures of impulsivity are not associated with NSSI.
- Discrepancies between findings are considered.
- Several suggestions for future research directions are offered.

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## ABSTRACT

Nonsuicidal self-injury (NSSI; direct self-injury without lethal intent) often is thought to be associated with impulse control problems. Recent research, however, offers conflicting results about whether impulsivity is a risk factor for NSSI engagement. To disentangle findings on the link between impulsivity and NSSI, an extensive review of the literature was conducted using several electronic databases (i.e., PsychInfo, PsychArticles, ERIC, CINAHL, and MEDLINE). In total, 27 studies that met the specific inclusion criteria were identified. Results of a meta-analysis revealed that individuals who engaged in NSSI self-reported greater impulsivity than individuals who did not engage in NSSI, and that this effect was most consistent for measures of negative urgency. In contrast, there was little evidence of an association between lab-based measures of impulsivity (e.g., Go/No-Go, Stop/Signal Task) and NSSI. Moreover, the link between impulsivity and NSSI found for self-report measures was sometimes eliminated when other risk factors for NSSI were controlled (e.g., abuse, depression, post-traumatic stress disorder). In addition to integrating findings, the present review provides several explanations for the discrepancies in findings between studies employing self-report versus lab-based measures of impulsivity. To conclude, several specific recommendations for future research directions to extend the literature on impulsivity and NSSI are offered.

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<sup>\*</sup> Corresponding author at: Department of Psychology, Brock University, St. Catharines, Ontario L2S 3A1, Canada. Tel.: +1 905 688 5550x5468; fax: +1 905 641 2509.  
E-mail addresses: [ch08za@brocku.ca](mailto:ch08za@brocku.ca) (C.A. Hamza), [teena.willoughby@brocku.ca](mailto:teena.willoughby@brocku.ca) (T. Willoughby), [th10ww@brocku.ca](mailto:th10ww@brocku.ca) (T. Heffer).

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## 1. Introduction

Nonsuicidal self-injury (NSSI), which is defined in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013)* as the direct and deliberate destruction of bodily tissue in the absence of suicidal intent, includes behaviors such as self-cutting, burning, hitting, and head-banging (Nock & Favazza, 2009). Among inpatient samples, as many as 21% of adults (Briere & Gil, 1998) and 30 to 45% of adolescents engage in NSSI (Cloutier, Martin, Kennedy, Nixon, & Muehlenkamp, 2010; Darche, 1990). Estimates of NSSI prevalence in the community also are concerning, with as many as 13 to 38% of adolescents and young adults reporting lifetime histories of NSSI (Gratz, Conrad, & Roemer, 2002; Hamza, Willoughby, & Good, 2013; Heath, Toste, Nedecheva, & Charlebois, 2008; Whitlock, Muehlenkamp, & Eckenrode, 2008). Given the widespread prevalence of NSSI, understanding risk factors for NSSI engagement has become an important priority.

One risk factor for NSSI that has received increasing empirical attention is impulsivity. NSSI has long been considered as a behavior associated with impulse control problems (i.e., acting rashly with little thinking or planning; Favazza & Conterio, 1989). Before being added as its own condition in the DSM-5, NSSI formerly was regarded as a symptom of Borderline Personality Disorder (BPD; American Psychiatric Association, 2013). A critical feature of BPD is impairment in impulse control (Evren, Cinar, Evren, & Celik, 2012; Lieb, Zanarini, Schmahl, Linehan, & Bohus, 2004). Despite past conceptualizations of NSSI as an impulsive behavior, however, recent empirical work on the link between impulsivity and NSSI has offered mixed findings. In the present review, we provide an extensive overview of studies that have examined the association between impulsivity and NSSI. Next, discrepancies in findings between studies using self-report and experimental measures of impulsivity are highlighted. Finally, findings are integrated and several recommendations for future research are offered.

## 2. Impulsivity

The term impulsivity has been described by researchers as an umbrella term that broadly encompasses a variety of traits, such as sensation-seeking, lack of planning, novelty seeking, lack of delay of gratification, and adventuresomeness (Costa & McCrae, 1992; Depue & Collins, 1999; Eysenck & Eysenck, 1977; Fischer, Smith, & Cyders, 2008; Glenn & Klonsky, 2010; Mullins-Sweatt, Lengel, & Grant, 2013). Many studies have implicated impulsivity in problem behavior engagement, such as alcohol use, drug use, disordered eating and other risky behaviors (Fischer, Anderson, & Smith, 2004; Heaven, Mulligan, Merrilees, Woods, & Fairouz, 2001; Lejuez et al., 2010; Perry & Carroll, 2008; Poulos, Le, & Parker, 1995). Inconsistency across studies in conceptualizations of impulsivity, however, makes it difficult to disentangle which aspects or facets of impulsivity are most closely associated with problem behavior engagement (including engagement in NSSI; Depue & Collins, 1999; Whiteside & Lynam, 2001).

Many predominant theories of personality and psychopathology have underscored the role of a variety of impulsivity-related traits in the prediction of behavior (for a review, see Pickering & Gray, 1999 or

Whiteside & Lynam, 2001). In their well-known theory of personality, Eysenck and Eysenck (1985) proposed that impulsivity consists of two factors: 1) venturesomeness (e.g., risk-taking, openness to new and exciting experiences) and 2) impulsiveness (e.g., acting without thinking; also see Eysenck, Pearson, Easting, & Allsopp, 1985), which make up lower-order dimensions of their three primary personality factors (i.e., neuroticism, extraversion, psychoticism). Venturesomeness was conceptualized by researchers as a lower-order dimension of extraversion, and impulsiveness was regarded as a lower-order dimension of psychoticism (Eysenck & Eysenck, 1985). In their model of temperament, Pickering and Gray (1999) suggested that impulsivity-related traits stem from sensitivity in the behavioral activation system (BAS) of the brain, resulting in high levels of approach-seeking behaviors, particularly sensation seeking. In contrast, other theories have primarily conceptualized impulsivity as the tendency to act without thinking (e.g., Buss & Plomin, 1975).

Two research groups have attempted to integrate past conceptualizations of impulsivity to create a more unified construct. Barratt and colleagues (Barratt, 1993; Patton, Stanford, & Barratt, 1995) developed a measure to assess what they proposed to be three central impulsivity factors: 1) motor impulsivity (acting without thinking), 2) nonplanning impulsivity (i.e., failure to plan ahead, “present focused”), and 3) attentional impulsivity (rapid decision making; BIS, Patton et al., 1995). Validation studies supported Barratt et al.’s three factors (Barratt, 1993; Patton et al., 1995), although some researchers only found support for two of the three factors (Luengo, Carrillo-De-La-Pena, & Otero, 1991). To further advance the field, Whiteside and Lynam (2001) conducted a large factor analysis on the predominant measures assessing impulsivity (e.g., Barratt Impulsiveness Scale, Patton et al., 1995; Personality Research Form Impulsivity Scale, Jackson, 1984; Sensation-Seeking Scale, Zuckerman, 1984). Four primary facets were identified that mapped onto the Five-Factor Model of personality (FFM, Costa & McCrae, 1992). The four factors included: 1) negative urgency (i.e., acting rashly in the context of negative emotions), 2) lack of premeditation (i.e., acting rashly with little thinking, planning or consideration of consequences), 3) lack of perseverance (i.e., inability to continue or remained focused on a difficult or boring task), 4) and sensation seeking (i.e., a predilection for novel or exciting experiences). Negative urgency was associated with neuroticism from the FFM, lack of perseverance and premeditation were associated with conscientiousness, and sensation seeking was aligned with openness to new experiences. On the basis of these findings, Whiteside and Lynam concluded that impulsivity is a heterogeneous measure that encompasses several lower-order personality traits which lead to impulsive behavior. Thus, Whiteside and Lynam urged that researchers should be explicit about the specific facets of self-reported impulsivity assessed in their studies (also see Smith et al., 2007).

Researchers also have employed lab-based measures of impulsivity to assess state impulsivity (i.e., at the time of measurement; Dick et al., 2010). Lab-based measures tend to assess five primary dimensions of impulsivity: 1) prepotent response inhibition (i.e., the ability to suppress one’s dominant response), 2) resistance to distractor interference (i.e., difficulty in ignoring a distraction that interferes with the task), 3) resistance to proactive interference (i.e., difficulty ignoring memory intrusions of irrelevant information that interferes with the

task), 4) delay response (i.e., difficulty delaying immediate gratification for long-term gain) and 5) distortions in elapsed time (i.e., difficulty in determining how much time has elapsed; [Dick et al., 2010](#); [Cyders & Coskunpinar, 2011](#)). Lab-based measures of impulsivity (e.g., Go/No-Go Task, immediate and delayed memory tasks, Stop/Signal Task) tend to be only moderately associated with self-report measures of impulsivity ([Dougherty & Marsh, 2003](#); [Logan & Cowan, 1984](#); [Newman & Kosson, 1986](#)). For example, when [Cyders and Coskunpinar \(2012\)](#) examined correlations among self-reported UPPS impulsivity traits and the five predominant measures of impulsivity assessed in lab-tasks, delay responding was moderately correlated with the different facets of impulsivity assessed by the UPPS, and prepotent response inhibition was modestly correlated with negative urgency and lack of perseverance. These findings suggest that researchers should not only be explicit about facets of impulsivity assessed, but also be careful about generalizing findings from self-report measures of impulsivity to lab-based assessments.

In recent years, [Whiteside and Lynam's \(2001\)](#) four impulsive traits (i.e., negative urgency, lack of premeditation, lack of perseverance, sensation seeking), have been widely adopted by researchers, and supported by findings on the validity of the UPPS measure ([Cyders et al., 2007](#); [Smith et al., 2007](#); for a review, see [Cyders, 2013](#)). Recent research has shown that each of these four constructs seems to be differentially related to problem behavior engagement ([Curcio & George, 2011](#); [Smith et al., 2007](#)). In a test of the discriminating ability of the UPPS, researchers found that negative urgency was most strongly associated with problem drinking, problem gambling and binge eating, while sensation seeking was more strongly associated with frequency of drinking ([Smith et al., 2007](#); see [Coskunpinar, Dir & Cyders, 2013](#) for the same findings using a meta-analytic approach). Similarly, in their meta-analytic review of the literature on impulsivity and bulimic symptoms, [Fischer et al. \(2008\)](#) found that negative urgency was by far the most strongly associated UPPS trait with bulimic symptoms. On the basis of these findings, researchers have suggested that negative urgency may be especially relevant to the study of psychopathology, because individuals who experience highly distressing affective situations may be especially motivated to engage in problem coping behaviors to provide immediate relief from distress ([Cyders & Smith, 2008](#); [Smith et al., 2007](#)).

### 3. NSSI

According to affect regulation function models (e.g. [Klonsky, 2007](#); [Nock, 2010](#); [Suyemoto, 1998](#)), individuals who experience frequent negative emotions are highly motivated to reduce these negative affect states (i.e., to provide quick and immediate relief of distress). NSSI is proposed to be one way that individuals are able to avoid or escape from these distressing emotional states ([Chapman, Gratz, & Brown, 2006](#); [Klonsky & Glenn, 2009](#); [Nock & Prinstein, 2004](#)). In support of the affect regulation function of NSSI, individuals who engage in NSSI report greater emotional dysregulation as compared to individuals who do not engage in NSSI ([Heath et al., 2008](#); [Muehlenkamp, Kerr, Bradley, & Larsen, 2010](#); [Muehlenkamp, Peat, Claes, & Smits, 2012](#)). Moreover, individuals who engage in NSSI report that NSSI regulates negative mood states, such as stress, anxiety, sadness, and self-directed anger ([Briere & Gil, 1998](#); [Klonsky & Glenn, 2009](#); [Nock & Prinstein, 2004](#); see [Klonsky, 2007](#) for a full review). Furthermore, recent ecological momentary assessment (EMA) studies demonstrate that NSSI tends to be preceded by increases in negative mood states and followed by decreases in negative emotions ([Armey, Crowther, & Miller, 2011](#); [Nock, Prinstein, & Sterba, 2010](#)). It has been proposed that NSSI may distract individuals from their emotional distress ([Chapman et al., 2006](#); [Selby & Joiner, 2009, 2013](#)) or provide relief through the release of endogenous opioids ([Bresin & Gordon, 2013](#); [Leknes, Brooks, Wiech, & Tracey, 2008](#)), but researchers are only beginning to test these hypotheses.

### 4. Impulsivity and NSSI

Recent research and theory suggest that individuals who are highly impulsive may be especially motivated to act rashly in the context of negative emotions because long-term benefits become less important than the immediate short-term gains of emotion regulation (e.g., The Theory of Urgency, [Cyders & Smith, 2008](#); also see [Tice, Bratslavsky, & Baumeister, 2001](#)). According to this theory, individuals may engage in problem coping behaviors (e.g., unhealthy eating, procrastination) to provide immediate relief from distress, at the expense of their long term goals or objectives (e.g., losing weight; [Tice et al., 2001](#)). Given that NSSI has been shown to be an effective way for individuals to regulate aversive emotions ([Armey et al., 2011](#); for a review see [Klonsky, 2007](#)), impulsive individuals (particularly those high in negative urgency) may be at high risk for NSSI engagement. Indeed, impulsive individuals may be highly motivated to obtain the immediate benefits of NSSI (e.g., emotion regulation) with less concern for the long-term consequences of NSSI engagement (e.g., scaring, discomfort, and stigmatization; [Chapman et al., 2006](#); [Fikke, Melinder, & Landro, 2013](#); [Klonsky, 2007](#)). NSSI engagement then, in turn, may be negatively reinforced by providing relief from distress, which increases the likelihood that individuals will engage in NSSI to regulate negative mood states again in the future ([Klonsky, 2007](#)). [Nock \(2010\)](#) also has proposed that impulsive individuals may be at risk for NSSI because NSSI can be performed quickly without much planning or preparation (e.g., going to a store). As a result, impulsive individuals may be more likely to choose NSSI over other coping behaviors (e.g., drinking alcohol, smoking).

Findings on the link between impulsivity and NSSI, however, have been mixed ([Glenn & Klonsky, 2010](#); [Janis & Nock, 2009](#)). Some researchers have reported a strong link between impulsivity and NSSI ([Glenn & Klonsky, 2010](#); [Ogle & Clements, 2008](#)), whereas other researchers have found no relation between these two constructs ([Bornoalova, Tull, Gratz, Levy, & Lejuez, 2011](#); [Chapman, Derbidge, Cooney, Hong, & Linehan, 2009](#)). To date, little attention has been given as to why these differences exist. In an effort to disentangle the findings on the link between impulsivity and NSSI, an extensive review of the literature was conducted in the present study. The first goal of the review was to assess whether individuals who engaged in NSSI differed from individuals who did not engage in NSSI on self-report measures of impulsivity. The second goal was to examine whether the link between impulsivity and NSSI varied depending on the impulsivity-trait assessed on two of the most widely used impulsivity measures: the UPPS ([Whiteside & Lynam, 2001](#)) and the BIS ([Patton et al., 1995](#)). On the basis of recent findings indicating that lab-based measures may assess different aspects of impulsivity than self-report measures, the third goal was to examine whether individuals who engaged in NSSI differed from individuals who did not engage in NSSI on lab-based measures of impulsivity. Finally, an assessment was made of whether the link between impulsivity and NSSI differed across study design (i.e., cross-sectional vs longitudinal), or when controlling for potential third variables (i.e., covariates).

### 5. Method

#### 5.1. Selection of studies and eligibility criteria

Given that the primary objective of the present review was to examine the link between impulsivity and NSSI, the authors agreed that only studies that included both an assessment of impulsivity and NSSI (and the link between these two behaviors) would be included in the review. Studies that assessed only impulsivity, only NSSI, or studies on the psychometric properties of scales used to measure impulsivity or NSSI were excluded. Only studies that assessed NSSI as self-injurious behaviors without lethal intent were included (i.e., articles on deliberate self-harm which assessed behaviors of varying suicidal intent were not included). After jointly establishing

these eligibility criteria, the authors selected the major and most widely used electronic search engines available, including PsychInfo, PsychArticles, ERIC, CINAHL, and MEDLINE. The search was limited to peer-reviewed articles written in English (the language written and spoken by all three authors) published up to July 1, 2014.

All authors were involved in developing the search terms used to conduct the literature review. Given that the term NSSI is relatively recent (DSM-5, [American Psychiatric Association, 2013](#); [Nock & Favazza, 2009](#)), a variety of previous commonly reported terms to assess self-injury without lethal intent were used for search purposes, including self-mutilation, self-injury, and deliberate self-harm. These terms were adopted from other recent reviews that sought to identify studies on NSSI (see [Hamza, Stewart, & Willoughby, 2012](#); [Victor & Klonsky, 2014](#)). All search terms were followed by a wildcard asterisk to allow for variation in these terms, and to maximize inclusivity. A broad search term of impulse (with an asterisk) also was used to capture different conceptualizations of this multi-faceted variable.

The study selection process used in the present review is outlined in [Fig. 1](#). In total, 278 articles were identified using the agreed upon search terms. After excluding study duplicates, 220 articles remained. Next, study abstracts were reviewed, and 187 studies were excluded that did not meet the specific inclusion criteria (e.g., study did not include an assessment of both impulsivity and NSSI, study did not differentiate non-lethal self-injury from lethal self-injury). The thirty-three studies that met the eligibility criteria were read in their entirety by all three authors. At this point, authors agreed to exclude six studies. Three of these studies assessed impulsivity using frequency of engagement in impulsive behaviors (e.g., drug and alcohol use) as a proxy for impulsivity, and three of these studies did not actually assess impulsivity (instead they measured time spent thinking about engaging in NSSI prior to the act). Thus, 27 articles remained and are summarized in the review. Authors coded several study characteristics (see [Appendix A](#)). There was a 91% agreement rate in characteristics extracted by the authors.

The present review provides both a qualitative and a quantitative review of the studies identified. The first section of the results provides a detailed narrative summary of the studies identified in the review. First, studies examining differences in self-reported impulsivity between individuals who engaged in NSSI and individuals who did not engage in NSSI are examined. Second, studies assessing differences on lab-based measures of impulsivity between individuals who engaged in NSSI and individuals who did not engage in NSSI are reviewed. In addition, a discussion of NSSI frequency in relation to impulsivity is provided. Next, a qualitative review of differences across studies depending on study design (i.e., cross-sectional vs longitudinal) is given, as well as a review of findings from studies including an assessment of covariates. To complement the narrative review, quantitative results from meta-analyses also are presented in the [Results](#) section. Meta-analyses were used to examine: 1) differences in self-reported impulsivity between individuals who engaged in NSSI and individuals who did not engage in NSSI, 2) whether differences on self-report measures varied across different impulsivity traits (as assessed on the UPPS and the BIS; [Whiteside & Lynam, 2001](#); [Patton et al., 1995](#)), and 3) differences on lab-based measures of impulsivity between individuals who engaged in NSSI and individuals who did not engage in NSSI. As the meta-analysis specifically focused on mean differences in impulsivity between individuals who engaged in NSSI and individuals who did not engage in NSSI, 10 studies out of the 27 that did not include that comparison were excluded from the analysis.

## 5.2. Meta-analytic procedure

Meta-analyses were conducted using procedures outlined by [Lipsey and Wilson \(2001\)](#) and [Card \(2012\)](#). Mean differences in impulsivity between individuals who engaged in NSSI and individuals who did not engage in NSSI were examined, and Cohen's *d* was used as the effect size. Effect sizes were calculated for each study using the effect size calculator by [Lipsey and Wilson \(2001\)](#). All effect sizes within each meta-

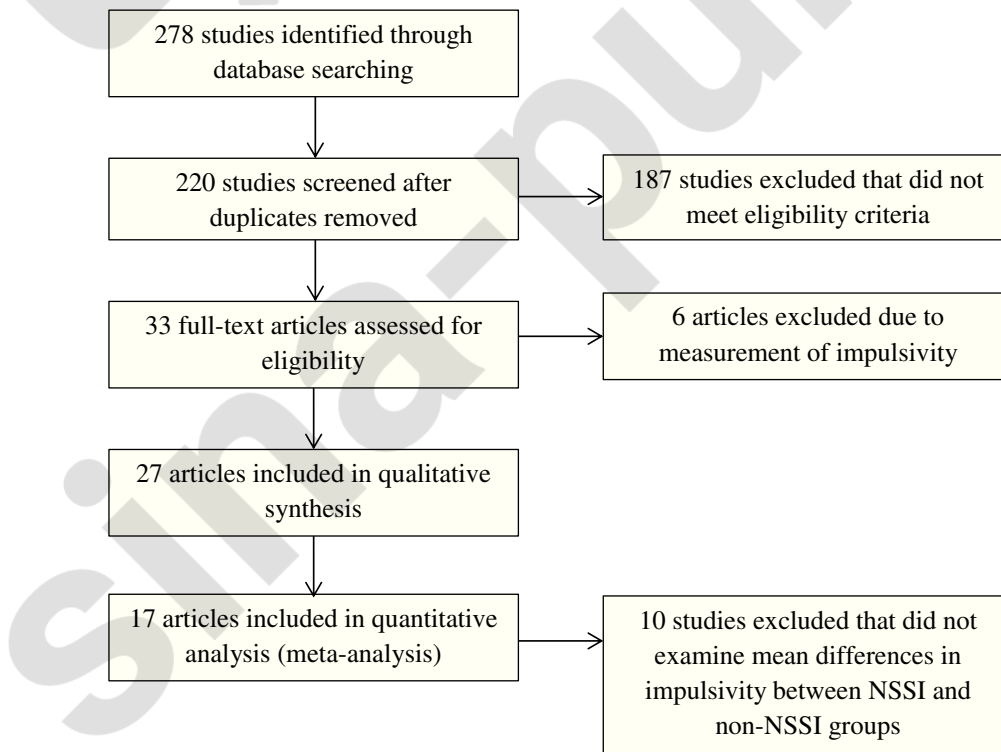


Fig. 1. Study selection.



analysis were from independent analyses. A random-effects model was administered for all analyses. The random effects model is more conservative than the fixed-effect model, in that the random effects model has wider confidence intervals than the fixed-effect model. A major advantage of the random effects model, however, is that the results can be generalizable beyond the specific studies included in the meta-analysis (Card, 2012; Lipsey & Wilson, 2001).

Effect sizes were checked for outliers by converting effect sizes to Z scores and assessing whether any scores were higher than  $Z = 3.29$ . If an outlier was found, rather than delete the study from the meta-analysis, the effect size was brought back into bounds (see Lipsey & Wilson, 2001). To assess whether the effect sizes for each meta-analysis were estimates of a single population, the  $I^2$  (true heterogeneity percentage) and Q statistics were calculated. The  $I^2$  statistic indicates how heterogeneous the effect sizes are, with Card (2012) suggesting that 25% represents a small amount of heterogeneity, 50% a medium amount, and 75% a large amount. A significant Q indicates that there is heterogeneity among effect sizes in the analysis, confirming the appropriateness of the random effects model. To test for publication bias, Orwin's (1983) effect size failsafe  $N$  was used as it indicates the magnitude of the robustness to the file drawer problem. The failsafe  $N$  reveals the number of studies with average effect size of 0 that would need to be added to the meta-analysis to reduce the observed mean effect size to a small effect (e.g., Cohen's  $d = .20$ ).

## 6. Results

### 6.1. Qualitative review

#### 6.1.1. NSSI vs no NSSI

Individuals who engaged in NSSI self-reported greater impulsivity, as assessed by the UPPS (Whiteside & Lynam, 2001), the Barratt Impulsiveness Scale (BIS, Patton et al., 1995), the impulse control subscale of the Difficulties with Emotion Regulation Scale (DERS, Gratz & Roemer, 2004), and the Schedule for Non-Adaptive and Adaptive Personality Impulsivity Subscale (SNAP-IMP, Clark, 1993), compared to individuals who did not engage in NSSI (e.g., Arens, Gaher, & Simons, 2012; Claes et al., 2013; Crowell et al., 2012; Dir, Karyadi & Cyders, 2013; Glenn & Klonsky, 2010; Herpertz, Sass, & Favazza, 1997). Undergraduate students with lifetime histories of NSSI significantly differed from individuals without a history of NSSI on impulsivity measures of negative urgency (Arens et al., 2012; Black & Mildred, 2013; Dir, Karyadi, & Cyders, 2013; Ogle & Clements, 2008) and lack of premeditation (Glenn & Klonsky, 2010; Mullins-Sweatt et al., 2013; Taylor, Peterson, & Fischer, 2012). Similarly, individuals who engaged in NSSI from inpatient adolescent and adult samples reported greater impulsivity than individuals who did not engage in NSSI (i.e., motor impulsivity and non-planning as assessed on the BIS; Claes et al., 2013; Evren et al., 2012; Herpertz et al., 1997; McCloskey, Look, Chen, Pajoumand, & Berman, 2012). The association between impulsivity and NSSI was found with male (Evren et al., 2012) and female participants (Claes et al., 2013; Crowell et al., 2012; Ogle & Clements, 2008), as well as among individuals with varying ethnic backgrounds, including Spanish (Claes et al., 2013), Italian (Di Pierro, Sarno, Perego, Gallucci, & Madeddu, 2012), American (Crowell et al., 2012; Dir et al., 2013; Ogle & Clements, 2008; St Germain & Hooley, 2012), Canadian (Cloutier et al., 2010), and German (Herpertz et al., 1997).

Among researchers who employed the four subscales of UPPS (i.e., negative urgency, lack of perseverance, lack of premeditation, sensation-seeking), negative urgency, in particular, was associated with NSSI engagement (Dir et al., 2013; Glenn & Klonsky, 2010; Mullins-Sweatt et al., 2013; Ogle & Clements, 2008; Taylor et al., 2012). In four of these five studies researchers found that individuals who engaged in NSSI also reported greater lack of premeditation than individuals who did not engage in NSSI (Dir et al., 2013; Glenn & Klonsky, 2010; Mullins-Sweatt et al., 2013; Ogle & Clements, 2008),

and in three studies individuals who engaged in NSSI reported greater lack of persistence than individuals who did not engage in NSSI (Dir et al., 2013; Glenn & Klonsky, 2010; Taylor et al., 2012). Individuals who engaged in NSSI also reported more impulsivity as assessed on the BIS, which has been found to be most closely associated with the premeditation factor on the UPPS Scale (Whiteside & Lynam, 2001).

In all three lab-based studies (Glenn & Klonsky, 2010; Janis & Nock, 2009; McCloskey et al., 2012), individuals who engaged in NSSI differed from individuals who did not engage in NSSI on self-report measures of impulsivity (including negative urgency and lack of premeditation; Glenn & Klonsky, 2010); findings using behavioral measures were less compelling. Glenn and Klonsky (2010) invited 168 Canadian undergraduate students into the lab to complete a Stop/Signal Task (SST; Logan & Cowan, 1984). The SST is a computer-based task that measures the participant's ability to inhibit a response when presented with a series of visual stimuli (e.g., press a key when an arrow is presented, but do not press a key when a stop sign is presented). Researchers found no differences between individuals who engaged in NSSI and individuals who did not engage in NSSI on this measure of inhibitory control, and response times on the SST were not correlated with NSSI frequency or recency of NSSI engagement.

In a similar set of studies, Janis and Nock (2009) examined differences between individuals who engaged in NSSI and individuals who did not engage in NSSI on three lab-based measures of impulsivity. The first task was the Iowa Gambling Task (IGT; Bechara, Damasio, & Anderson, 1994), which assessed risky decision making (i.e., a tendency to minimize risk) by having participants choose cards with greater gain or loss potential. By choosing smaller rewards over larger rewards, participants experienced smaller losses over time, resulting in a higher total score. Participants also completed the Conner's Continuous Performance Test (CPT; Conner, 1995), which required participants to inhibit a response when a particular stimulus was presented on a computer (i.e., a measure of inhibitory control, similar to the Stop/Signal task). Finally, participants completed two Delay Discounting Tasks (Kirby, Petry, & Bickel, 1999; Richards, Zhang, Mitchell, & Wit, 1999), which examined participants' preferences for immediate smaller rewards over later larger rewards. Across both studies, individuals who engaged in NSSI did not differ from individuals who did not engage in NSSI on the lab-based measures of impulsivity (Janis & Nock, 2009). Researchers concluded that the non-significant finding might be because their participants were recruited primarily from psychiatric clinics. This explanation, however, does not account for why individuals who engaged in NSSI were more impulsive than individuals who did not engage in NSSI on self-report measures.

Finally, similar to Janis and Nock (2009), McCloskey et al. (2012) examined whether individuals who engaged in NSSI differed from individuals who did not engage in NSSI using three lab-based measures of impulsivity, including the Immediate Memory Task (IMT; Dougherty & Marsh, 2003), the Go/No-go task (Newman & Kosson, 1986), and the Bechara Gambling Task (BGT; Bechara et al., 1994). The Immediate Memory Task (IMT) was very similar to the Conner's Continuous Performance Task (CPT) used by Janis and Nock (2009), such that participants were told to inhibit responses to specific stimuli (i.e., to press a key if a number matched the previously presented number, but not to press a key if the number differed from the previous number). The Go/No-go task also assessed inhibitory control, by testing whether participants could inhibit responses to "incorrect" stimuli (i.e., only press the key when a correct number appears) to avoid errors and obtain rewards. The Bechara Gambling Task was very similar to the Iowa Gambling task, in that participants were instructed to choose from various decks, with preferences for larger immediate rewards also producing larger losses over time. Consistent with Glenn and Klonsky (2010) and Janis and Nock, McCloskey et al. found that individuals who engaged in NSSI did not differ from individuals who did not engage in NSSI on any of the lab-based measures of impulsivity. It is interesting to note, however, that McCloskey and colleagues included a lab-based measure

of self-injury (i.e., the Self-Aggression Paradigm), and found that participants who self-selected greater shocks as punishment for losses against what they believed was another opponent, behaved more impulsively on the IMT and Go/No-go task. Researchers concluded, therefore, that individuals may be more likely to behave impulsively specifically in the context of NSSI incidents.

#### 6.1.2. Frequency of NSSI

Impulsivity also was found to be positively associated with NSSI frequency (i.e., number of incidents of NSSI; Arens et al., 2012; Dir et al., 2013; Evren et al., 2012; Peterson & Fischer, 2012; Simeon et al., 1992), number of methods of NSSI (Claes & Muehlenkamp, 2013; Dir et al., 2013; Lynam, Miller, Miller, Bornovalova, & Lejuez, 2011) and severity (Black & Mildred, 2013). Dir et al. (2013) found that greater impulsivity (i.e., lack of planning, positive urgency, negative urgency) predicted greater frequency of NSSI engagement, greater number of NSSI methods (e.g., cutting, burning), and more years spent engaging in NSSI among high school students. In contrast to these findings, however, Di Pierro et al. (2012) found that individuals who engaged in more frequent NSSI reported less impulsivity than individuals who engaged in less frequent NSSI, and Taylor et al. (2012) found that individuals who engaged in current self-injury (i.e., NSSI within the past month) did not differ from individuals with lifetime histories on measures of impulsivity. Other studies found a small but significant effect (e.g., Evren et al., 2012; Glenn & Klonsky, 2010; Simeon et al., 1992). Overall, additional research on impulsivity and NSSI is needed to examine individual differences in frequency of NSSI engagement, as well as recency (i.e., past year or past month) of engagement among individuals who engage in NSSI.

#### 6.1.3. Covariates

There were mixed findings as to whether impulsivity was associated with NSSI when studies controlled for potential third variables (i.e., covariates). In several studies researchers found that negative urgency differentiated young adults who engaged in NSSI from young adults who did not engage in NSSI when controlling for gender, negative affect, child maltreatment (Arens et al., 2012), disordered eating (Black & Mildred, 2013), depression, anxiety, and alcohol use (Glenn & Klonsky, 2010, 2011). Similarly, Herpertz et al. (1997) found that individuals who engaged in NSSI reported more impulsivity (i.e., non-planning and motor impulsivity on the BIS) than individuals who did not engage in NSSI, when controlling for depression in their sample of individuals with BPD.

In contrast, controlling for risk factors for NSSI engagement in other studies resulted in a non-significant link between impulsivity and NSSI (see Bornovalova et al., 2011; Carli et al., 2010; Evren et al., 2012; Rodav, Levy, & Hamdan, 2014). Carli et al. (2010) found that impulsive males (i.e., who scored above the 75th percentile) were more likely than non-impulsive males (i.e., who scored below the 25th percentile) to engage in NSSI; however, the link between impulsivity and NSSI was eliminated when controlling for depression, childhood trauma, depression, and aggression. Similarly, Sacks, Flood, Dennis, Hertzberg, and Beckham (2008) found that individuals who engaged in NSSI reported greater impulsivity than individuals who did not engage in NSSI, but that impulsivity was not a multivariate predictor of NSSI status (controlling for age, PTSD, depressive symptoms, alcohol use and severity). Controlling for multiple factors that are highly related to NSSI engagement, therefore, may reduce the predictive value of impulsivity on NSSI.

#### 6.1.4. Study design

Another important finding from the present review is that most of the literature on impulsivity and NSSI is cross-sectional, and there is limited longitudinal support for the predictive value of impulsivity on NSSI engagement. Specifically, only four studies that involved multiple assessments of impulsivity and NSSI over time were identified (Black

& Mildred, 2013; Chapman et al., 2009; Glenn & Klonsky, 2011; Peterson & Fischer, 2012). In three of these studies, negative urgency was concurrently associated with NSSI engagement (Black & Mildred, 2013; Glenn & Klonsky, 2011; Peterson & Fischer, 2012). When researchers examined whether impulsivity at Time 1 was associated with NSSI engagement at Time 2, however, findings were mixed. In two studies researchers found that negative urgency at Time 1 was not associated with NSSI frequency of engagement one year later (Glenn & Klonsky, 2011; Peterson & Fischer, 2012), but Black and Mildred (2013) found that negative urgency at Time 1 did predict NSSI engagement at Time 2 (Time 1 scores were not controlled). Further longitudinal research is needed to assess whether impulsivity is associated with changes in NSSI over time, taking into account levels of NSSI engagement at Time 1.

### 6.2. Quantitative review

#### 6.2.1. NSSI vs no NSSI

In 17 studies, researchers compared self-reported impulsivity scores between individuals who engaged in NSSI and a comparison group of individuals who did not engage in NSSI. One outlier was found (3.8 SD over the mean; Crowell et al., 2012), which was brought back into bounds (see Lipsey & Wilson, 2001). When these studies were meta-analyzed (regardless of the impulsivity measure assessed), there was a significant mean difference between the two groups ( $d = 0.593$ ), indicating a medium mean effect size – see Table 1. Individuals who engaged in NSSI reported greater impulsivity than individuals who did not engage in NSSI. To specifically examine whether the different facets of impulsivity identified by Whiteside and Lynam (2001) were differentially related to NSSI, a meta-analysis of the mean differences between individuals who engaged in NSSI and individuals who did not engage in NSSI was conducted separately for each UPPS subscale – see Table 2. The largest mean effect size was for negative urgency ( $d = .591$ , a medium effect). In contrast, small mean effect sizes were observed for lack of perseverance ( $d = 0.319$ ) and premeditation ( $d = 0.233$ ), and a trivial but statistically-significant mean effect size was found for sensation seeking ( $d = 0.142$ ; with all analyses indicating that individuals who engaged in NSSI scored higher on the impulsivity subscales than individuals who did not engage in NSSI). The mean effect size for negative urgency was homogeneous (i.e., the Q statistic was non-significant and the  $I^2$  statistic was 0),

**Table 1**

Summary of meta-analytic results of mean differences in impulsivity between NSSI and non-injurer groups.

k (no of studies)	17
N (aggregate) of NSSI groups	1599
N (aggregate) of non-injurer groups	2652
Mean weighted effect size ( $d$ )	.593
95% confidence interval	0.430–0.755
Z-test of the mean effect size	7.157***
Standard error	.083
Heterogeneity (Q; df 16)	78.886***
$I^2$ (true heterogeneity percentage)	79%
Orwin's effect size failsafe $N^a$	33

Notes: NSSI = nonsuicidal self-injury; Studies included in meta-analysis: Claes et al. (2013), Cloutier et al. (2010), Crowell et al. (2012), Di Pierro et al. (2012), Dir et al. (2013)<sup>b</sup>, Evren et al. (2012), Glenn and Klonsky (2010)<sup>b</sup>, Herpertz et al. (1997), Janis and Nock (2009)<sup>c</sup>, McCloskey et al. (2012), Mullins-Sweatt et al. (2013)<sup>b</sup>, Ogle and Clements (2008)<sup>b</sup>, Rodav et al. (2014), St Germain and Hooley (2012), Sacks et al. (2008), Simeon et al. (1992), Taylor et al. (1992)<sup>b</sup>.

\*\*\*  $p < .001$

<sup>a</sup> Orwin's effect size failsafe  $N$  = number of studies with average effect size of 0 required to reduce the observed mean effect size to Cohen's  $d = .20$  – see Orwin, 1983.

<sup>b</sup> Few studies reported the total scores for the UPPS. As only one effect size from a sample can be included in a meta-analysis, only the data from the negative urgency subscale was included (but see Table 2 for differences among all the UPPS subscales).

<sup>c</sup> Janis and Nock's Study 1 only.

**Table 2**

Summary of meta-analytic results of mean differences between NSSI and Non-injurer groups on each of the UPPS impulsivity subscales.

	NegUrg	LackPers	LackPrem	SensSeek
K (number of studies)	5	5	5	5
N (aggregate) of NSSI groups	548	548	548	548
N (aggregate) of non-injurer groups	1190	1190	1190	1190
Mean weighted effect size ( <i>d</i> )	.591	.319	.233	.142
95% confidence interval	0.480–0.701	0.090–0.548	0.052–0.414	0.015–0.269
Z-test of the mean effect size	10.472***	2.730**	2.529*	2.193*
Standard error	.056	.117	.092	.065
Heterogeneity (Q; df 4)	2.139	16.486**	10.300*	5.259
I <sup>2</sup> (true heterogeneity percentage)	0%	76%	61%	24%
Orwin's effect size failsafe N <sup>a</sup>	10	3	1	–1

Notes: NSSI = nonsuicidal self-injury; NegUrg = negative urgency subscale; LackPers = lack of perseverance subscale; LackPrem = lack of premeditation subscale; SensSeek = sensation-seeking subscale; studies included in meta-analysis: Dir et al. (2013), Glenn and Klonsky (2010), Mullins-Sweatt et al. (2013), Ogle and Clements (2008), and Taylor et al. (2012).

\*  $p < .05$ .\*\*  $p < .01$ .\*\*\*  $p < .001$ .

<sup>a</sup> Orwin's effect size failsafe *N* = number of studies with average effect size of 0 required to reduce the observed mean effect size to Cohen's  $d = .20$  – see Orwin (1983).

indicating consistency across studies. Heterogeneity also was non-significant for sensation-seeking, although again the mean effect size for that construct was trivial.

There were four studies that employed the BIS measure, which includes three subscales (i.e., attentional impulsiveness; motor impulsiveness, and non-planning impulsiveness). A meta-analysis of mean differences between individuals who engaged in NSSI and individuals who did not engage in NSSI was conducted separately for each BIS subscale – see Table 3. There was a significant mean difference between the two groups across all three subscales,  $d = .596$ ,  $d = .615$ , and  $d = .501$  respectively (all medium mean effect sizes), indicating that impulsivity was higher among individuals who engaged in NSSI compared to individuals who did not engage in NSSI. Although these mean effect sizes are comparable to that found for negative urgency on the UPPS, there was significant heterogeneity in mean effect sizes across the studies for all BIS subscales. Significant heterogeneity indicates a lack of consistency across the studies.

There were only three studies in which researchers also included lab-based (behavioral) measures of impulsivity to examine the link between impulsivity and NSSI engagement (Glenn & Klonsky, 2010; Janis & Nock, 2009; McCloskey et al., 2012). A meta-analysis of the mean difference between individuals who engaged in NSSI and individuals who did not engage in NSSI across the studies employing lab-based measures of impulsivity revealed a non-significant mean effect size that was near zero ( $d = .0106$ ). Further analyses (e.g., moderator

analyses, a meta-analysis of studies examining the correlation between NSSI frequency and impulsivity, models controlling for covariates) were not conducted (a) due to the small number of available studies, (2) because NSSI frequency was strongly skewed in many of the studies and there was little consistency across studies in how the skewness was addressed, or (c) because the studies varied in the covariates that they included, impeding aggregate analyses. These studies, however, were included in the qualitative review.

## 7. Discussion

The results of the present review indicate that individuals who engage in NSSI self-reported greater impulsivity concurrently, relative to individuals who do not engage in NSSI (Arens et al., 2012; Claes & Muehlenkamp, 2013; Crowell et al., 2012; Di Pierro et al., 2012; Dir et al., 2013; Glenn & Klonsky, 2010; Lynam et al., 2011; Mullins-Sweatt et al., 2013; Ogle & Clements, 2008; St Germain & Hooley, 2012; Taylor et al., 2012). These differences were most pronounced for measures of negative urgency, and to a lesser extent for lack of premeditation and perseverance. There were no differences between individuals who engaged in NSSI and individuals who did not engage in NSSI, however, on lab-based measures of impulsivity (Glenn & Klonsky, 2010; Janis & Nock, 2009; McCloskey et al., 2012). Moreover, the link between impulsivity and NSSI found for self-report measures was eliminated in some studies when researchers controlled for other risk factors for NSSI (Bornova et al., 2011; Carli et al., 2010; Evren et al., 2012; Rodav et al., 2014; Sacks et al., 2008). Longitudinal research on the link between impulsivity and NSSI also was limited and findings were mixed (Chapman et al., 2009; Glenn & Klonsky, 2011; Peterson & Fischer, 2012). The results of the present review, therefore, highlight the need for additional research on impulsivity and NSSI.

The results of the review underscore the importance of assessing associations among the different components of impulsivity and NSSI. Several measures of impulsivity were associated with NSSI engagement (BIS, Patton et al., 1995; DERS, Gratz & Roemer, 2004; SNAP-IMP, Clark, 1993), but different impulsivity-traits varied in their strength of association with NSSI behaviors. Consistent with past conceptualizations of impulsivity as acting rashly without thinking or planning (e.g., Buss & Plomin, 1975), several researchers found that lack of premeditation (as assessed on the UPPS) was associated with NSSI engagement. The three subscales of the BIS, which were found to be most strongly associated with the lack of premeditation trait on the UPPS (Whiteside & Lynam, 2001), also were associated with NSSI engagement. These findings suggest that individuals who often act quickly with little planning may be at greater risk for NSSI than individuals who act with greater deliberation, and are consistent with previous research that has implicated

**Table 3**

Summary of meta-analytic results of mean differences between NSSI and non-injurer groups on each of the BIS impulsivity subscales.

	Attentional	Motor	Non-planning
K (number of studies)	4	4	4
N (aggregate) of NSSI groups	304	304	304
N (aggregate) of non-injurer groups	577	577	577
Mean weighted effect size ( <i>d</i> )	.596	.615	.501
95% confidence interval	0.240–0.952	0.186–1.044	0.176–0.825
Z-test of the mean effect size	3.282**	2.810**	3.021**
Standard error	.182	.219	.166
Heterogeneity (Q; df 4)	12.551*	18.282**	10.589*
I <sup>2</sup> (true heterogeneity percentage)	76%	84%	72%
Orwin's effect size failsafe N <sup>a</sup>	8	8	6

Notes: NSSI = nonsuicidal self-injury; studies included in meta-analysis: Claes et al. (2013), Evren et al. (2012), Herpertz et al. (1997), and McCloskey et al. (2012).

\*  $p < .05$ .\*\*  $p < .01$ .

<sup>a</sup> Orwin's effect size failsafe *N* = Number of studies with average effect size of 0 required to reduce the observed mean effect size to Cohen's  $d = .20$  – see Orwin (1983).



lack of deliberation and planning with other health-risk behaviors such as alcohol use (Jones, Chrysanthakis, & Groom, 2014; Willoughby & Fortner, 2014) and problem eating behaviors (Claes, Vandereycken, & Vertommen, 2005).

Individuals who engaged in NSSI also reported less perseverance (i.e., the ability to remain focused or to complete a difficult or boring task) than individuals who did not engage in NSSI. Interestingly, this finding is consistent with recent research that suggests that individuals who engage in NSSI report lower levels of distress tolerance, relative to individuals who do not engage in NSSI. Indeed, Nock and Mendes (2008) found that individuals who engaged in NSSI discontinued a distressing card-sorting task sooner (i.e., the Distress Tolerance Test, DTT) and demonstrated greater physiological arousal (as assessed by skin conductance) than individuals who did not engage in NSSI during this distress task. Our findings, in combination with Nock and Mendes's findings, suggest that individuals who are motivated to avoid distressing situations may be more likely to engage in NSSI.

Researchers who employed the UPPS consistently found that negative urgency was most strongly associated with NSSI (over and above the other components of impulsivity; Dir et al., 2013; Glenn & Klonsky, 2010; Lynam et al., 2011; Peterson & Fischer, 2012; Taylor et al., 2012). Recent theory suggests that in the context of intense negative affect, individuals may engage in coping behaviors to provide immediate relief from distress, at the expense of long-term regulatory goals (Cyders & Smith, 2008; Tice et al., 2001). Impulsive behaviors are likely to be immediately reinforced over time if they provide relief from negative emotions (Cyders & Smith, 2008). Given that NSSI serves as a way to reduce negative emotions (Klonsky & Glenn, 2009; Nock & Prinstein, 2005), impulsive individuals may engage in NSSI because of its immediate benefits (with little regard for long-term consequences). Critically, the results of the present review suggest that individuals who engage in NSSI may behave more impulsively than individuals who do not engage in NSSI particularly in the context of negative emotions. It will be important for researchers, therefore, to provide clear definitions and descriptions of the types of impulse behavior assessed within their studies (Cyders & Smith, 2008).

The finding that negative urgency, in particular, was associated with NSSI also may help to account for differences between studies employing self-report versus lab-based measures of impulsivity. The UPPS measure includes an assessment of impulsivity in the context of negative emotions (e.g., "When I'm upset I often act without thinking," Whiteside & Lynam, 2001), but lab-based studies have not included mood manipulations prior to assessing behavioral measures of impulsivity (Glenn & Klonsky, 2010; Janis & Nock, 2009; McCloskey et al., 2012). If individuals who engage in NSSI are impulsive primarily in the context of negative mood states, differences may not emerge between individuals who engage in NSSI and individuals who do not engage in NSSI on lab-based tasks until participants are asked to perform the task under conditions of distress (Glenn & Klonsky, 2010; Janis & Nock, 2009). It also is interesting to note that Bresin, Carter, and Gordon (2013) found that sadness, in particular, interacted with impulsivity to predict NSSI urges in their daily diary study. Bresin et al.'s finding suggests that it will be worthwhile for researchers to induce various emotions (e.g., sadness, anger, guilt) prior to assessing impulsivity to determine which emotional contexts may be most associated with NSSI.

Future research also should explore other possible reasons (i.e., other than the absence of mood inductions prior to lab-based tasks) for the discrepancies in findings between self-report and lab-based measures of impulsivity. Recall that recent research indicates that self-report measures of impulsivity assess different aspects of impulsive behavior than do lab-based measures (Cyders & Coskunpinar, 2012; Dick et al., 2010). In a recent meta-analysis, Cyders and Coskunpinar (2011) found that self-report measures of impulsivity were only weakly correlated with behavioral measures. In all of the experiments examined in the present review, self-report measures of

impulsivity were poorly correlated with lab-based measures of impulsivity (Glenn & Klonsky, 2010; Janis & Nock, 2009; McCloskey et al., 2012). Glenn and Klonsky (2010) found small non-significant correlations between the Stop-Signal Task (SST) and self-reported impulsivity on the UPPS. As noted by Cyders and Coskunpinar, self-report and behavioral measures of impulsivity assess different aspects of impulsivity (e.g., trait vs state); therefore, researchers should interpret differences between self-report and behavioral measures of impulsivity cautiously.

Consistent with the results of our review, several researchers have found that self-reported impulsivity is associated with other health-risk behaviors, such as alcohol and drug use (Magid & Colder, 2007; Papachristou et al., 2013). In a recent meta-analysis on the link between self-report impulsivity (as assessed by the UPPS) and alcohol use, it was found that lack of premeditation was associated with drinking frequency, and negative urgency was strongly associated with drinking problems (Coskunpinar, Dir, & Cyders, 2013; also see Magid & Colder, 2007). It is interesting to note, however, that similar to our findings, results with lab-based measures were less compelling. Some researchers reported finding an association between impulsivity (as assessed using lab-based measures) and alcohol and drug use (Colder & O'Connor, 2002; Henges & Marcinski, 2012), and other researchers found no association (Fernie, Cole, Goudie, & Field, 2010; Kamarajan et al., 2005). These findings underscore the importance of assessing how different impulsivity traits (as assessed by both lab and self-report measures) are related to health-risk behaviors.

Discrepancies between self-report and experimental studies also may stem from differences in perceived, rather than objective, impulsive behavior among individuals who engage in NSSI (Bresin et al., 2013; Janis & Nock, 2009; McCloskey et al., 2012). Specifically, individuals who engage in NSSI may not actually be more impulsive than individuals who do not engage in NSSI, but may perceive themselves as more impulsive (i.e., a bias captured by self-report methods). According to Janis and Nock (2009), individuals who engage in NSSI may make appraisals about their impulsivity using NSSI engagement as reference for their impulsive behavior ("I am impulsive because I self-injure"). Given that individuals who engage in NSSI typically do so soon after they experience the urge to self-injure (Csorba, Dinya, Plener, Nagy, & Pali, 2009; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007; Nock & Prinstein, 2005), it is possible that individuals who engage in NSSI regard themselves as impulsive because of their NSSI engagement. McCloskey et al. (2012) highlight, however, that individuals who engage in NSSI report greater engagement in a variety of impulsive or risky behavior behaviors than individuals who do not engage in NSSI (e.g., Gollust, Eisenberg, & Golberstein, 2008; Serras, Saules, Cranford, & Eisenberg, 2010), suggesting that there may be differences in impulsivity between individuals who engage in NSSI and individuals who do not engage in NSSI. Research involving multiple assessments (i.e., ecological momentary sampling, daily diaries) specifically could examine this hypothesis. Researchers also should include follow-up questions to determine if NSSI engagement is used to make decisions about self-report ratings of impulsivity (e.g., "Provide an example of a time you behaved impulsively." "Would your friends describe you as impulsive, and why or why not?").

Another important direction for future research will be to examine individual differences in impulsivity among individuals who engage in NSSI. In most of the research in the present review, researchers examined mean differences in impulsivity among individuals who engaged in NSSI and individuals who did not engage in NSSI. There may be variability, however, among individuals who engage in NSSI on measures of risk. Recent research has revealed that there are mild, moderate and severe subgroups of individuals who engage in NSSI that can be differentiated on the basis of psychosocial impairment (i.e., depressive symptoms, anxiety, BPD, history of childhood abuse; Klonsky & Olino, 2008; Whitlock et al., 2008). It may be that individuals with varying levels of NSSI engagement (e.g., frequency, severity, recency) may vary in the extent to which they engage in impulsive behavior. Applying



person-centered approaches to the study of impulsivity and NSSI (e.g., latent class analysis, growth-mixture modeling) could provide new insight into the conditions under which impulsivity is associated with NSSI engagement.

Another significant and important limitation of the existing literature on impulsivity and NSSI is that studies are largely cross-sectional. Only four longitudinal studies were identified (Black & Mildred, 2013; Chapman et al., 2009; Glenn & Klonsky, 2011; Peterson & Fischer, 2012) and these studies offered little support for the longitudinal link between impulsivity and NSSI. Importantly, these longitudinal studies often precluded an examination of changes in NSSI engagement over time, given that baseline levels of NSSI were not taken into account. In addition, studies often were limited by the use of small sample sizes and a short-term longitudinal focus (i.e., one year period). No previous research also has specifically examined the direction of effects between NSSI and impulsivity, so it is unclear whether impulsivity leads to NSSI, or whether NSSI leads to increased impulsivity over time. Future research involving large sample sizes with multiple assessments of impulsivity and NSSI (i.e., annually across several years) will allow researchers to specifically examine bidirectional associations among impulsivity and NSSI over time.

It also is important for researchers to explore whether the link between impulsivity and NSSI varies cross-culturally. As was noted in the *Qualitative review* section, we found that the link between impulsivity and NSSI was robust across participants from varying demographic regions, including countries in North America such as the United States (Dir et al., 2013; Ogle & Clements, 2008) and Canada (Cloutier et al., 2010; Glenn & Klonsky, 2010), as well as several European countries such as Italy (Di Pierro et al., 2012), Belgium (Claes & Muehlenkamp, 2013), Spain (Claes et al., 2013) and Germany (Herpertz et al., 1997). It is important to note, however, that participants in these studies were overwhelmingly identified as Caucasian. There were only a few studies that included an examination of the link between impulsivity and NSSI among minority samples (e.g., African, Bornoalova et al., 2011; Lynam et al., 2011; Sacks et al., 2008); thus, the results of the review may not be generalizable to more diverse racial/ethnic populations.

A further limitation of our review is that the meta-analysis included only a small number of published studies that compared individuals who engaged in NSSI to group of individuals who did not engage in NSSI ( $N = 17$ ). It is noteworthy, however, that our sample size was comparable to another recently published meta-analysis on NSSI (Batejan, Jarvi, & Swenson, 2014). Nevertheless, it is important to acknowledge that our quantitative results are based on a small set of studies (particularly our analyses assessing whether the different facets of impulsivity were differentially related to NSSI), and it is possible that unpublished null findings on the link between impulsivity and NSSI could reduce the strength of association identified in the meta-analyses. The results of the Orwin's effect size failsafe  $N$  suggest, however, that there would need to be 33 studies with an average effect size of 0 required to reduce the observed mean effect size to Cohen's  $d = .20$  (a small effect size, see Orwin, 1983). The present effect size was comparable to findings from other meta-analyses on NSSI (to our knowledge, the only two meta-analyses on NSSI). Klonsky and Moyer (2008) found a small effect size ( $d = .47$ ) between childhood sexual abuse and impulsivity, and Batejan et al. (2014) found a moderate effect size between sexual orientation and impulsivity ( $d = .61$ ; effects were converted to Cohen's  $d$ , see Borenstein, Hedges, Higgins, & Rothstein, 2009).

An extension for future research also will be to disentangle associations among NSSI, impulsivity, and suicidal behavior. Recent theory and research suggest that NSSI is a risk factor for suicidal behavior (Asarnow et al., 2011; Prinstein et al., 2008; Wilkinson, Kelvin, Roberts, Dubicka, & Goodyear, 2011). According to Joiner (2005), individuals who engage in NSSI may develop increased pain tolerance for more lethal forms of self-injury over time (i.e., acquired capability for suicide; Van Orden et al., 2010). Impulsive individuals may be more likely to engage in NSSI

than individuals who are less impulsive, which in turn, may lead to increased risk for suicidal behavior over time (Joiner, 2005). Indeed, recent findings suggest that the link between impulsivity and suicidal behavior may actually be mediated by NSSI engagement (Anestis, Tull, Lavender, & Gratz, 2014). Given that researchers have found a significant link between impulsivity and suicidal behavior (e.g., Doihara et al., 2012; Kasen, Cohen, & Chen, 2011; Klonsky & May, 2010), future longitudinal research could specifically investigate this possible mediational pathway (i.e., impulsivity predicts suicidal behavior through NSSI).

Additional longitudinal research involving assessments of other risk factors also could provide new insight into the processes through which impulsivity and NSSI are associated (i.e., possible mediation and moderation effects). Recall that findings on the link between impulsivity and NSSI were mixed when researchers controlled for possible third variables in their models. Some researchers reported a robust association between negative urgency and NSSI controlling for multiple risk factors (e.g., negative affect, depression, alcohol use; child maltreatment; Arens et al., 2012; Glenn & Klonsky, 2010), and other researchers found that impulsivity was not associated with NSSI when controlling for other risk factors (e.g., BPD, PTSD; depressive symptoms, suicidal ideation; Bornoalova et al., 2011; Rodav et al., 2014; Sacks et al., 2008). To disentangle associations among risk factors for NSSI engagement, studies involving the assessment of multiple risk factors are needed. Arens et al. (2012) found that impulsivity (i.e., a more proximal risk factor) mediated the link between childhood maltreatment (i.e., a more distal risk factor) and NSSI engagement. The examination of interactions among multiple risk factors over time using longitudinal data designs could offer a greater understanding of the developmental pathways of NSSI engagement.

Finally, despite findings that self-reported impulsivity was associated with NSSI, it remains unclear why individuals who are impulsive choose to engage in NSSI, rather than other health-risk behaviors. Nock (2010) suggests that individuals may specifically choose NSSI because it requires little planning or preparation (i.e., a highly accessible means of coping behavior), but there is research to suggest that individuals who engage in NSSI are more likely to engage in other risk behaviors too, such as drug use and purging behaviors (Gollust et al., 2008; Hamza et al., 2013; Peterson & Fischer, 2012; Serras et al., 2010). Longitudinal research exploring pathways from impulsivity to multiple risk behaviors may provide increased insight into which risk behaviors are most strongly associated with impulsivity.

In conclusion, the results of our review provide some evidence that impulsive individuals, particularly those who report high levels of negative urgency (i.e., acting rashly in the context of negative mood states), may be at increased risk for NSSI engagement. Although longitudinal research on the link between impulsivity and NSSI is needed, our findings suggest that teaching impulsive individuals who self-injure more effective emotion-focused coping strategies may be a useful form of clinical intervention. In particular, teaching individuals who self-injure coping strategies that can be performed quickly with little planning or preparation during overwhelming emotional experiences (e.g., relaxation breathing, meditation) may provide individuals with alternative and more effective means than NSSI to regulate aversive emotional states.

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#### Contributors

Chloe Hamza, Teena Willoughby and Taylor Heffer conducted the literature searches, and provided research summaries of the studies reviewed. Chloe Hamza, Teena Willoughby, and Taylor Heffer coded the study characteristics, and Teena Willoughby and Chloe Hamza conducted the statistical analyses in the meta-analysis. Chloe Hamza and Teena Willoughby wrote the first draft of the manuscript, and all authors contributed to the revised draft, and approved the final manuscript.

**Conflict of Interest**

All authors declare that they have no conflicts of interest.

**Appendix A. Supplementary data**

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.cpr.2015.02.010>.

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