

Emotion Regulation
**– An Empirical Investigation in Female Adolescents with Nonsuicidal Self-
Injury**

**Emotionsregulation – Eine empirische Untersuchung bei weiblichen Jugendlichen mit
nichtsuzidaler Selbstverletzung**

Inauguraldissertation

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by

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I hereby declare that I have written the submitted doctoral thesis “Emotion Regulation – An Empirical Investigation in Female Adolescents with Nonsuicidal Self-Injury” without any assistance from third parties not indicated. Furthermore, I confirm that no other sources have been used in the preparation and writing of this thesis other than those indicated.

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“Wer nicht zuweilen zu viel empfindet, der empfindet immer zu wenig”

Jean Paul

“I don't want to be at the mercy of my emotions. I want to use them, to enjoy them, and to dominate them”

Oscar Wilde

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Abstract

Nonsuicidal self-injury (NSSI) was included as a condition for further study in the *DSM-5*. Therefore, it is necessary to investigate the suggested diagnostic criteria and the clinical and psychological correlates. In order to provide an optimal treatment best tailored to the patients need, a clear differentiation between Borderline Personality Disorder (BPD) and NSSI is needed. The investigation of personality traits specific to patients with NSSI might be helpful for this differentiation. Furthermore, social difficulties can often be a trigger for NSSI. However, little is known about how adolescents with NSSI perceive social situations. Therefore, we examined how adolescents with NSSI process emotional expressions. A new emotion recognition paradigm (ERP) using colored and morphed facial expressions of happiness, anger, sadness, disgust and fear was developed and evaluated in a student sample, selected for being high (HSA) or low socially anxious (LSA). HSA showed a tendency towards impaired emotion recognition, and the paradigm demonstrated good construct validity.

For the main study, we investigated characteristics of NSSI, clinical and psychological correlates, personality traits and emotion recognition. We examined 57 adolescents with NSSI diagnosis, 12 adolescents with NSSI without impairment/distress and 14 adolescents with BPD, 32 clinical controls without NSSI, and 64 nonclinical controls. Participants were interviewed regarding mental disorders, filled out self-report questionnaires and participated in the ERP.

Results indicate that adolescents with NSSI experienced a higher level of impairment than clinical controls. There were similarities between adolescents with NSSI and adolescents with BPD, but also important differences. Adolescents with NSSI were characterized by specific personality traits such as high harm avoidance and novelty seeking compared to clinical controls. In adolescents with BPD, these personality traits were even more pronounced. No group differences in the recognition of facial expressions were found. Nonetheless compared to the control group, adolescents with NSSI rated the stimuli as significantly more unpleasant and arousing.

In conclusion, NSSI is a highly impairing disorder characterized by high comorbidity with various disorders and by specific personality traits, providing further evidence that NSSI should be handled as a distinct diagnostic entity. Consequently, the proposed *DSM-5* diagnostic criteria for NSSI are useful and necessary.

Abstract in German (deutsche Zusammenfassung)

Die nichtsuizidale Selbstverletzung (NSSV) wurde im *DSM-5* als Störung zur weiteren Erforschung aufgenommen. Daher ist es wichtig, die vorgeschlagenen Diagnosekriterien hinsichtlich ihrer diagnostischen, klinischen und psychologischen Korrelate zu untersuchen. Zusätzlich ist eine klare Abgrenzung zur Borderline Persönlichkeitsstörung (BPS) notwendig, hierbei könnte die Untersuchung von Persönlichkeitseigenschaften helfen. Soziale Schwierigkeiten dienen oft als Auslöser von NSSV. Dennoch ist wenig erforscht, wie Jugendliche mit NSSV soziale Situation wahrnehmen.

Ein neues Emotionserkennungsparadigma mit farbigen, dynamischen emotionalen Gesichtsausdrücken wurde entwickelt und an einer studentischen Stichprobe evaluiert, die für ihre hohe (HSA) oder niedrige soziale Ängstlichkeit (LSA) ausgewählt wurde. HSA zeigten eine Tendenz zu einer beeinträchtigten Erkennung von Gesichtsausdrücken. Des Weiteren konnte eine gute Konstruktvalidität für das Paradigma festgestellt werden.

In der Hauptstudie untersuchten wir die Charakteristika von NSSV, die Persönlichkeitseigenschaften und die Emotionserkennung bei 57 Jugendlichen mit NSSV, 12 Jugendlichen mit NSSV ohne Einschränkung und Leiden, 13 Jugendlichen mit BPS, einer klinischen Kontrollgruppe ($n = 32$) und einer nicht-klinischen Kontrollgruppe ($n = 64$). Die Teilnehmer wurden bezüglich psychischer Störungen befragt, füllten Fragebögen aus und nahmen am Emotionserkennungsparadigma teil.

Die Ergebnisse zeigten auf, dass Jugendliche mit NSSV im Vergleich zur klinischen Kontrollgruppe eine erhöhte Psychopathologie aufwiesen. Weiterhin fanden sich Gemeinsamkeiten sowie Unterschiede zwischen den Jugendlichen mit NSSV und Jugendlichen mit BPS. Jugendliche mit NSSV kennzeichnen sich durch eine hohe Schadensvermeidung und hohes Neugierverhalten im Vergleich zur klinischen Kontrollgruppe. Bei Jugendlichen mit BPS waren diese Persönlichkeitseigenschaften noch ausgeprägter. Weiterhin, konnten keine Gruppenunterschiede bezüglich der Emotionserkennung gefunden werden. Jugendliche mit NSSV bewerteten jedoch die Gesichtsausdrücke als unangenehmer und emotional aufwühlender.

Zusammenfassend zeigt sich NSSV als stark einschränkende Störung, die mit einer hohen Komorbidität einhergeht und mit spezifischen Persönlichkeitseigenschaften assoziiert ist. Die Ergebnisse liefern zusätzliche Evidenz für die neue Diagnose NSSV und weisen darauf hin, dass die vorgeschlagenen *DSM-5* Kriterien hilfreich und notwendig sind

1. Summary

Im Rahmen der vorliegenden Dissertation werden Ergebnisse dreier Studien präsentiert, welche die klinischen Symptome, die Persönlichkeit und die Fähigkeit zur Emotionserkennung bei weiblichen Jugendlichen mit nichtsuizidaler Selbstverletzung untersuchen. Zusätzlich wird eine Studie zur Validierung des Emotionserkennungsparadigmas berichtet.

Die Einführung gibt einen Überblick über den aktuellen Forschungsstand zu nichtsuizidaler Selbstverletzung (NSSV). Anschliessend wird im Theorieteil das in der Studie verwendete Emotionskonzept mit den drei Aspekten Emotionserkennung, emotionale Mimikry und Emotionsregulation erläutert. Die soziale Angst wird im Zusammenhang mit der Fähigkeit zu emotionaler Mimikry, Emotionserkennung und Emotionsregulation, vorgestellt. Bezüglich NSSV werden die Kriterien, die klinischen und diagnostischen Korrelate, sowie Persönlichkeitseigenschaften und Impulsivität erläutert. Weiterhin werden Studien zur Emotionserkennungsfähigkeit bei Jugendlichen mit NSSV berichtet.

Im Anschluss werden die Ziele der Studien erläutert, die verwendeten Methoden dargestellt und eine Zusammenfassung der Ergebnisse wird präsentiert. In der generellen Diskussion werden die Ergebnisse in einen weiteren Kontext eingebettet und die Stärken sowie die Limitationen der Studien werden diskutiert. Abschliessend wird auf klinische Implikationen für die Behandlung von nichtsuizidaler Selbstverletzung eingegangen.

Im Anhang werden vier empirische Studien aufgeführt. Die erste Studie untersuchte das Emotionserkennungsparadigma bei Studenten mit hoher und niedriger sozialer Ängstlichkeit. Zusätzlich wurden die Nachahmung von Emotionen und Emotionsregulationsschwierigkeiten untersucht (Ruf, Kirmse, Wilhelm, Schmid, & In-Albon, submitted for publication, Appendix A). Die zweite, dritte und vierte Studie untersucht NSSV in einem stationären klinischen Setting. Die zweite Studie untersuchte die Güte der neuen DSM-5 Kriterien für die nichtsuizidale Selbstverletzung. Zusätzlich werden klinische und diagnostische Korrelate berichtet (In-Albon, Ruf, Schmid, 2013, Appendix B). Die dritte Studie untersuchte die Persönlichkeitseigenschaften von Jugendlichen mit nichtsuizidaler Selbstverletzung (Ruf, Tschan, Schmid, In-Albon, submitted for publication, Appendix C) und die vierte Studie beschäftigte sich mit der Emotionserkennungsfähigkeit (In-Albon, Ruf, & Schmid, submitted for publication, Appendix D).

2. Introduction

When asked for reasons of their self-injurious acts, adolescents with nonsuicidal self-injury (NSSI) most frequently report that the act helped to regulate negative emotions (e.g. In-Albon, Ruf, & Schmid, 2013; Nock & Cha, 2009; Zetterqvist, Lundh, Dahlstrom, & Svedin, 2013). Therefore, NSSI is primarily used as a maladaptive strategy to cope with intense emotions, often resulting from intra- and interpersonal difficulties (Nock, 2010). For the development of successful NSSI specific treatments, a better understanding of how individuals with NSSI regulate their emotions seems promising. Furthermore, we need to understand the intra- and interpersonal difficulties that trigger these negative emotions.

NSSI, the intentional, self-inflicted damage to the surface of a person's body without suicidal intent and for other than socially accepted reasons (American Psychiatric Association [APA], 2013; Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007), is a very common phenomenon among adolescents, with lifetime prevalence rates of at least one self-injuring event around 18% in community samples worldwide (Muehlenkamp, Claes, Havertape, & Plener, 2012; Swannell, Martin, Page, Hasking, & St John, 2014). Studies using the proposed DSM 5 criteria reported rates between 4% and 7% for adolescent community samples and around 50% for child and adolescent psychiatric samples (for a review see Plener, Kapusta, Brunner, & Kaess, 2014). The onset of NSSI typically occurs around age 13 or 14 (Rodham & Hawton, 2009). A recent review on the longitudinal course of NSSI suggests an increase of NSSI in young adolescents with a peak around 15 to 17 years, followed by a remission in young to middle adulthood (Plener, Schumacher, Munz, & Groschwitz, 2015). A study from the general population (Moran et al., 2012) indicates that the majority of adolescent's self-injury will remit in short periods of time, but other findings (Wilkinson, Kelvin, Roberts, Dubicka, & Goodyer, 2011) suggest that a history of self-harm is an important clinical marker for subsequent suicide.

Klonsky (2011) reported a 5.9% lifetime prevalence of NSSI in adult community samples. This inconsistency of higher lifetime prevalence rate in adolescents compared to adults seems to be caused rather by a memory bias of adults than by an increase of prevalence rates in the last years (Plener et al., 2015), as systematic reviews found no indication for a rise of prevalence rates if they adjusted for methodological factors (Muehlenkamp et al., 2012; Swannell et al., 2014). Checklists generate higher estimates than single item questionnaires. Checklist might be more accurate because it requires respondents to take time to process each item while a single item questionnaire is a free recall task (Schaeffer & Presser, 2003),

possibly lowering estimates because respondents may not recall episodes of NSSI without prompts. Unfortunately, many ethics committees oppose the use of detailed checklists due to fear that they might encourage the behaviours, despite research demonstrating that asking about self-destructive behaviours (including NSSI) does not increase risk of engaging in these behaviours (Muehlenkamp, Walsh, & McDade, 2010).

Research about predictors and functions of NSSI is highly relevant as they could inform preventive interventions. Nock (2009) has proposed an integrated theoretical model of the development and maintenance of NSSI, taken into account results of previous studies. According to this model, NSSI is caused by the interplay of multiple risk factors. Distal risk factors include genetic predisposition for high emotional/cognitive reactivity, childhood abuse/maltreatment, and familial hostility/criticism. General predisposing factors comprise both intrapersonal and interpersonal factors, such as high aversive emotion and poor communication skills. The model further proposes that reinforcement processes perpetuate NSSI. Consistent with this model, NSSI primarily serves intrapersonal negative reinforcement, by alleviating overwhelming negative emotion (Nock & Prinstein, 2005; Klonsky, 2007). Recent ecological momentary assessment (EMA) studies demonstrate that NSSI is preceded by increases in negative mood states and followed by decreases in negative emotions (Armeij, Crowther, & Miller, 2011; Nock, Prinstein, & Sterba, 2010). However, another EMA study of affect states among adolescents with self-injury and bulimia nervosa showed an increase of positive affect after NSSI (Muehlenkamp et al., 2009), providing evidence for positive intrapersonal reinforcement. The model by Nock (2009) further proposes that social functions reinforce NSSI through positive (e.g., obtaining personal resources) and negative factors (e.g., avoiding interpersonal demands; Nock & Cha, 2009).

As there are many possibilities for regulating negative emotions, it remains unclear, why persons with NSSI choose this method. According the self-punishment hypothesis, NSSI simultaneously serves punishing the self. Indeed, slightly more than one-half of people report that they self-injure as a form of self-directed anger or self-punishment (Nock, Wedig, Holmberg, & Hooley, 2008). Another hypothesis is the social signalling hypothesis, postulating that NSSI serves to produce a physical sign of emotional distress. Furthermore, NSSI could represent an attempt to communicate and connect with others, particularly when less extreme attempts at communication fail to produce results (Nock, 2008). Nevertheless, interpersonal functions of NSSI are rarely experimentally investigated, even though self-report studies indicated high relevance of these functions for patients with NSSI behaviour (Baetens, Claes, Muehlenkamp, Grietens, & Onghena, 2011; Lloyd-Richardson, et al., 2007;

Nock & Prinstein, 2004). In line with these findings, social interaction problems are often a trigger for NSSI (Nock & Mendes, 2008).

Regarding characteristics and methods of NSSI, Nixon, Cloutier, and Aggarwal (2002) studied 42 hospitalized adolescents with repetitive NSSI. More than 80% reported almost daily urges to self-injure, and more than 60% reported at least once-a-week acts of self-injury. All endorsed cutting and/or scratching. Self-cutting seems to be the most prevalent method, often used methods are scratching, banging the head or other parts against the wall, burning, punching, and inserting sharp objects to the nail or skin (Sornberger, Heath, Toste, & McLouth, 2012; You, Leung, Lai, & Fu, 2015).

2.1 New Developments in the Research Area

For decades, knowledge about nonsuicidal self-injury was limited to only a small handful of empirical studies. However, the last 10 to 15 years have witnessed an explosion of research and significant advances in knowledge about NSSI (Klonsky, Victor, & Saffer, 2014). NSSI was not in the classification system of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* or the *International Classification of Diseases, 10th revision (ICD-10)* as a distinct entity, but it did exist as a symptom of BPD. Partially thanks to the increased research interest NSSI was included as a condition for further study in *DSM-5*, indicating that criteria sets will need further research before it will be an official diagnosis (APA, 2013). Other reasons for the inclusion were high prevalence (Giletta, Scholte, Engels, Ciairano, & Prinstein, 2012) as well as severe prognostic implications of NSSI (Asarnow et al., 2011). Establishing a diagnosis for NSSI might be of high importance since it leads to a better understanding, management and to the development of specific treatments. More recently, Wilkinson and Goodyer (2011) suggested in addition to these benefits several positive consequences, such as improving communication between professionals and patients. In addition, a diagnosis is also the base to provide financing from health insurances. In the past, many patients with NSSI were officially diagnosed with comorbid diagnoses or with BPD, even without fulfilling all required criteria. In addition to the stigma associated with a BPD diagnosis, this led to the problem that psychotherapy might not focus on the primary disorder and as consequence might pursued psychotherapeutic goals different from that relevant for the treatment of NSSI. However, without an official diagnosis there is a discrepancy and in-transparency between communication to the patient and health insurance companies.

3. Emotions

Emotions like happiness, anger, sadness and anxiety shape our life and psychosocial experiences as well as our social relationships. In the understanding of the author, emotions are seen as complex reactions of an organism to important external or internal situations, which trigger reactions on a behavioural, perceptual or physiological level (Frijda, 1986). Emotions can be distinguished from moods. Moods often last longer than emotions, whereas emotions are typically elicited by specific events (Parkinson, Totterdell, Briner, & Reynolds, 1996). For many, the core of emotion is subjective experience (Barrett, Mesquita, Ochsner, & Groos, 2007; LeDoux, 2012). Emotions shape our social interactions, by influencing our facial expressions, gestures and behaviours (Ekman, Friesen, & Ellsworth, 1972).

Emotions are helpful. For example, fear leads us to avoid potentially deadly fights, happiness reinforces new friendships, and anger propels us to fight for causes we care about (Gross, 2015). However, emotions are harmful when they are the wrong intensity, duration, frequency, or type for a particular situation, or when they distort cognition and behaviour (Gross & Jazaieri, 2014), for example when anger drives a person to harm herself.

Emotionally competent individuals are characterized by optimal emotion production and emotion recognition (Scherer, 2007). Whereas emotion production competence refers to the appropriateness of the total pattern of the expressed emotions, allowing the individual to successfully cope with its consequences, emotion perception competence refers to the ability to accurately perceive and interpret the emotional state of others in social intercourse. Emotion recognition and one part of emotion production, facial mimicry, shall be looked at in more detail. In our point of view, both abilities are closely linked to emotion regulation as shall be explained.

3.1 Emotion Recognition

Perception of the human face as well as the social cues derived from it, is central to social interaction (Argyle, 1994). The ability to accurately infer emotional facial expressions is of high importance for guiding one's own behaviour and regulating one's own emotional state in social contexts. Marsh, Kozak and Ambady (2007) indicated that the ability to recognize fear in facial expressions predicts prosocial behaviour. Misinterpretation of facial expressions due to dysfunctions in perception are likely to result in emotional disturbances, inadequate social behaviours, lack of social skills, and less adaptive social problem-solving skills. These

problems are often observed in adolescents with NSSI (Claes, Klonsky, Muehlenkamp, Kuppens, & Vandereycken, 2010; Nock & Mendes, 2008).

There is a link between emotion recognition and emotion regulation. Yoo, Matsumoto & LeRoux (2006) concluded that emotion recognition is a precursor to emotion regulation, in the sense that if emotion is not recognized, there is nothing to regulate. If emotional facial expressions are not recognized correctly, emotion regulation will be affected. In Nock's integrated model of NSSI (2009), a dysfunctional emotion regulation seems to be partially responsible for self-injuring behaviours.

Facial emotion recognition can be influenced by the individual's current mood (Mullins & Duke, 2004). The information-processing theory proposes that mood affects perception and attention (Dodge, 1991). For example, Lee, Ng, Tang & Chan (2008) indicated that participants in a sad mood tended to classify ambiguous faces as negative. Additionally, Chepenik, Cornew and Farah (2007) showed that sad mood interfered with facial emotion recognition. However, these studies investigated adults from community samples. Studies with a clinical sample of adolescents examining the effect of a mood induction on emotion recognition are still missing.

3.2 Emotional Mimicry

With regard to the definition of Hess and Fischer (2013), we define emotional mimicry as the imitation of the emotional facial expression of another person. Already new-borns imitate specific facial expressions (Field, Woodson, Greenberg, & Cohen, 1982; Meltzoff & Moore, 1977). Historically, mimicking reactions were seen as an automatic response based on a perception-behaviour link (Chartrand & Bargh, 1999). The matched motor hypothesis assumes that the sole perception of a specific facial expression automatically entrains the same expression in the perceiver. This idea is consistent with research showing that specific pre-motor neurons, called mirror neurons, fire not only when an action is performed but also when the same action is observed (Goldman & Sripada, 2005).

However, currently scientists doubt the simplicity of the perception-behaviour link, especially when it comes to emotional mimicry. For instance, emotional mimicry could also be detected within subjects when they heard emotional sounds (Hawk, Fischer, & Van Kleef, 2012; Hietanen, Surakka, & Linnankoski, 1998; Magnee, Stekelenburg, Kemner, & de Gelder, 2007; Verona, Patrick, Curtin, Bradley, & Lang, 2004). Furthermore, if it would be a perception-behaviour link, the facial mimicry effect should be relatively stable across contexts. However, as

an example, one's own emotion can influence emotional mimicry (Moody, McIntosh, Mann, & Weisser, 2007). A negative attitude towards someone inhibits facial mimicry (Bourgeois & Hess, 2008; Likowski, Mühlberger, Seibt, Pauli, & Weyers, 2008), whereas being in a good relationship (Fischer, Becker, & Veenstra, 2012) or the belonging to the same social group (Bourgeois & Hess, 2008; van der Schalk et al., 2011) fosters mimicry. Hess and Fischer (2013) considered emotional mimicry as a case of embodied simulation, where the embodied simulation both elicits liking and rapport for us in our interlocutor, and seems to support emotional understanding.

Therefore, mimicking behaviour could be the key to a successful interaction. By fostering affiliation and liking mimicking might be the "social glue" as it often has been referred to (Lakin, Jefferis, Cheng, & Chartrand, 2003). Smiles are generally perceived as more relationship promoting than frowns or disgusted faces (Hess, Blairy, & Kleck, 2000; Knutson, 1996). Moreover, angry faces are signals for a lack of affiliative intent. Furthermore, those whose facial expressions convey negative emotions (e.g., disgust) are viewed negatively (van Kleef, 2009). Therefore, the imitation of positive emotions is more likely to foster affiliation and liking in an interactional partner than the imitation of negative emotions.

A recent review indicates that sufficient evidence exists only for the emotional mimicry effect of anger and happiness, with their corresponding muscles *m. corrugator supercilii* and *m. zygomaticus major* (Hess & Fischer, 2013). Therefore, confirmation of emotional mimicry effects for disgust, anxiety, sadness, and other emotions is still necessary.

It has been suggested that emotional mimicry facilitates emotion recognition because facial muscles function as a feedback system for a person's own experience of emotion (Hatfield, Cacioppo, & Rapson, 1994). Indeed, blocking mimicry leads to a less accurate recognition of happiness (Niedenthal, Mermillod, Maringer, & Hess, 2010) and a slower recognition of happiness, sadness and fear (Lydon & Nixon, 2014). However, studies in which mimicry was measured rather than blocked did not find any association between the degree of mimicry and the level of emotion recognition (Fischer, et al., 2012; Hess & Blairy, 2001).

3.3 Emotion Regulation

Emotion and emotion regulation are that closely linked that some authors see them as indistinguishable, because every emotion is regulated to some extent (Frijda, 1986). As described by Gross (2002, p. 282), contemporary research defines emotion regulation as the processes by which individuals influence which emotions they have, when they have them, and how they

experience and express them. According to Aldao (2013), the goal of emotion regulation is not to eliminate maladaptive emotions and replace them with adaptive ones but rather to influence the dynamics of each emotion in order to produce adaptive responses to the environment. For example when giving a presentation, intensive anxiety could lead to freezing or fleeing, whereas a little amount of anxiety will be activating and helpful for focussing on the task. To a large extent, when asked about emotion regulation, people describe efforts to down-regulate negative and to up regulate positive emotions (Quoidbach, Berry, Hansenne, & Mikolajczak, 2010). However, sometimes counter hedonic regulation might be motivated by instrumental goals (Tamir, 2009), such as increasing anger when trying to collect payment on debts (Sutton, 1991). Gross (2002) suggest a process model of emotion regulation (Figure 1). Based on the time course of situation, attention, appraisal and response, the model proposes five emotion regulation strategies, divided into antecedent- and response-focused strategies. Antecedent-focused strategies start even before an emotion emerges. “*Situation selection*” refers to efforts made to influence emotion by either increasing or decreasing the likelihood of encountering a given situation where particular emotions are likely elicited. “*Situation modification*” includes control and active change of the situation, e.g. to make the situation feel safer through security behaviour, whereas “*attention deployment*” helps regulating emotions by directing one’s attention in a particular way in a given situation. Focusing on social threat could be one explanation, why socially anxious endure social performance problems in unstructured situations (Hofmann, Gerlach, Wender, & Roth, 1997; Pilkonis, 1977). Reappraisal, i.e., giving events a new meaning, is considered a “*cognitive change*”. Last, as the only response-focused strategy, people may alter physiological, experiential, or behavioural responses in a situation, for example by suppressing them. This is referred to as “*response modulation*”. So far, cognitive change is seen as one of the most effective strategies for emotion regulation (Webb, Miles, & Sheeran, 2012). However, if this strategy is used without considering situational circumstances, it might lead to a worse outcome of the situation, for example participants told to reappraise their emotions accepted more unfair offers than participants without instructions (van’t Wout, Chang, & Sanfey, 2011).

This model assumes that suppression leads to a reduction of positive and negative facial expressions, masking important social signals. Indeed, Butler et al. (2003) found less positive facial affects during interaction and inhibited perception of social signals in others, in individuals who use emotion suppression. Furthermore, individuals using suppression seem to be evaluated as less likeable by others in comparison to people using reappraisal as emotion regulation strategy.

If we adapt this model to social situations, it seems coherent that suppression would affect the ability to display facial mimicry. Furthermore, our mimic reaction to someone else's facial expression is likely to influence the situation by modulating the reactions of our fellows. For example, we are much more likely to continue smiling at someone, if he/she smiles back at us.

Emotional recognition is likely to influence the appraisal we experience in social situations. Facial expressions are important sources of how others evaluate us (Phillips, Drevets, Rauch, & Lane, 2003). Our own interpretation of the picture the other person might have of us is likely to influence our feelings. For example, if someone reacts with a happy facial expression to a gift, we are more likely to feel good in that situation than when he reacts with a frown. Consequently, our recognition of the others' emotion can influence the action we are taking afterwards.

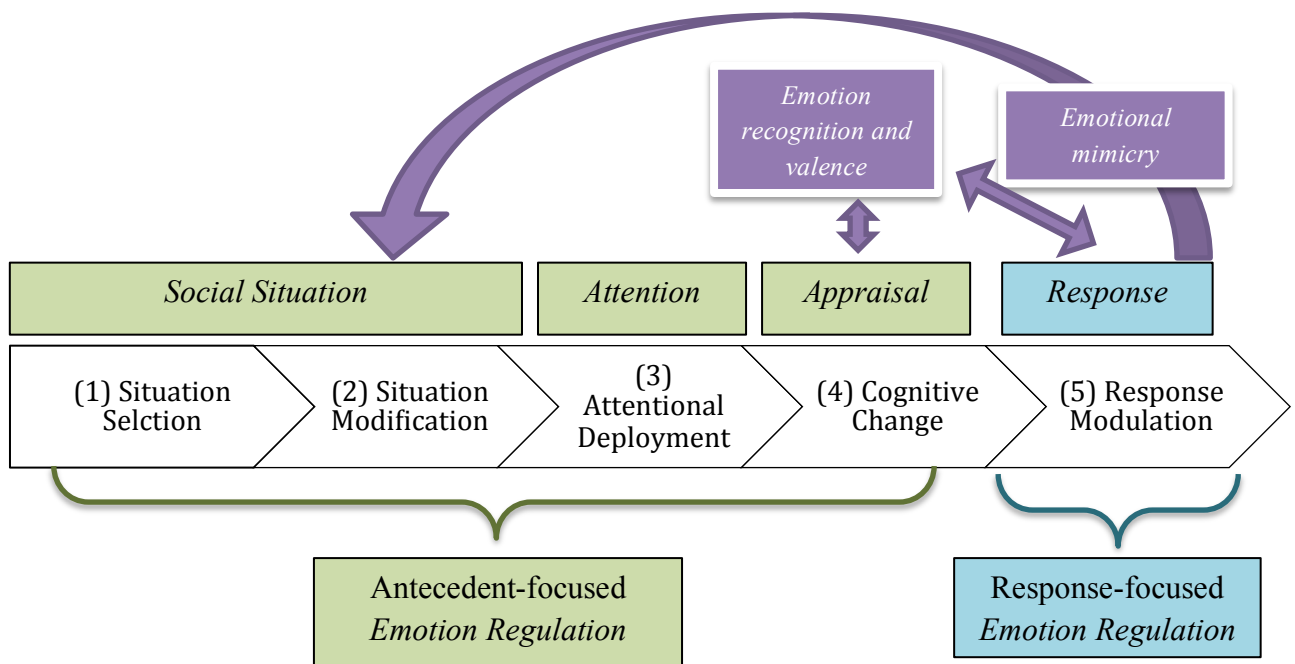


Figure 1. Adapted process model of emotion regulation (Gross, 2002). According to this model, emotions may be regulated at five points in the emotion generative process. (1) selection of the situation; (2) modification of the situation; (3) deployment of attention; (4) change of cognitions; and (5) modulation of experiential, behavioural, or physiological responses. The first four are antecedent-focused strategies; the fifth is a response-focused strategy. In purple: hypothesis, how emotion recognition, valence of the facial expression and emotional mimicry might influence emotion regulation in social situations.

An alternative model of emotion regulation was proposed by Gratz and Roemer (2004). They define four processes:

1. The awareness and understanding of emotions
2. The acceptance of emotions
3. The ability to control impulsive behaviour and act purposefully
4. The ability to use emotion regulation strategies adapted to the situation, to modulate the emotions as wished and to reach the goals.

The difficulties in emotion regulation questionnaire (DERS; Gratz & Roemer, 2004) was developed according to this model. In a meta-analysis on emotion regulation strategies Aldao, Nolen-Hoeksema and Schweizer (2010) examined the relationship between specific strategies and psychopathology across four psychopathologies (anxiety, depression, eating and substance-related disorders). They found a large effect size for the strategy rumination, medium to large effect sizes for avoidance, problem solving, and suppression as emotion regulation strategies, and small to medium effect sizes for reappraisal and acceptance. These results are surprising, given the prominence of reappraisal and acceptance in treatment models, such as cognitive-behavioural therapy and acceptance-based treatments, respectively. Although this result represents an important insight in the understanding of emotion regulation deficits, the study lacks an understanding of how these regulation strategies are linked to and interact with each other by evaluating their influence only separately. Understanding the association between the different strategies is particularly important in the light of growing recognition that people's ability to flexibly implement strategies is associated with better mental health (Aldao & Nolen-Hoeksema, 2012). Furthermore, emotion regulation strategies are neither adaptive nor maladaptive but must be considered within the context and goals in a given situation (Aldao & Nolen-Hoeksema, 2012). Emotion dysregulation can be conceptualized as a state in which emotion regulatory attempts fail to achieve emotion related goals (Jazaieri, Urry, & Gross, 2013). Emotion dysregulation seems to be involved in a lot of psychiatric disorders, for example the failed regulation of anxiety in anxiety disorders (Cole, Michel, & Teti, 1994) or the difficulties in controlling anger in BPD. Therefore, emotion regulation has been increasingly integrated into models of psychopathology over the past decades (Berenbaum, Raghavan, Le, Vernon, & Gomez, 2003; Kring & Bachorowski, 1999; Mennin & Farach, 2007).

4. Social Anxiety

Social Anxiety Disorder (SAD), a marked fear or anxiety about one or more social situations in which the individual is exposed to possible scrutiny by others (APA, 2013), is related to clinically significant impairment in social, occupational, and other important areas of functioning. Social anxiety is a construct that is particularly debated regarding the distinction between dimensional and categorical descriptions of psychopathology (Potuzak, Ravichandran, Lewandowski, Ongur, & Cohen, 2012). On the one hand, symptoms of social anxiety are common even in high-functioning community samples, while on the other hand, SAD is a mental disorder with high impairment (Bögels et al., 2010) and SAD is associated with reduced social interactions and impaired social support (Katzelnick et al., 2001). So far, treatment for SAD has not been as successful as treatments for other anxiety disorders, indicated by a moderate treatment effect for SAD compared to good effects for other anxiety disorders regarding symptom reduction (Stewart & Chambless, 2009) and more importantly regarding quality of life (Hofmann, Wu, & Boettcher, 2014). Therefore, improvements in the treatment of SAD are necessary. A better understanding of the fear of negative evaluation in social anxiety (SA) could lead to improvements in treatments. For the explanation of the fear of negative evaluation in individuals with SA several theories exist. Possible explanations are enhanced attention to potential sources of social threat (Rapee & Heimberg, 1997), social skills deficits (Rapee & Heimberg, 1997; Schlenker & Leary, 1982) and emotion regulation deficits (Hofmann, 2007), as shall be explained in more detail. A wealth of empirical research has demonstrated associations between social anxiety or SAD and attentional bias towards social threat (e.g., facial expressions of anger or disgust) in probe detection and probe discrimination tasks (for a review see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). But these effects have not been replicated consistently across samples (e.g., Kolassa & Miltner, 2006).

Furthermore, patients with SAD are suspected to have poorer social skills and therefore they experience repeated interpersonal failure (Rapee & Spence, 2004), which can increase social anxiety. So far, studies on social skills deficits brought mixed results, for a review see Levitan and Nardi (2009). In children and adolescents, participants with SAD seem to present an important deficit in social interaction with same-age confederates (Alfano, Beidel, & Turner, 2006; Beidel, Turner, & Morris, 1999; Inderbitzen-Nolan, Anderson, & Johnson, 2007; Spence, Donovan, & Brechman-Toussaint, 1999), but slight differences are

noticed in performance tasks, like an impromptu speech (Alfano, et al., 2006; Beidel, et al., 1999; Cartwright-Hatton, Tschernitz, & Gomersall, 2005; Inderbitzen-Nolan, et al., 2007; Spence, et al., 1999). In adult samples, the only significant differences in social skills are found in unstructured situations (Hofmann, et al., 1997; Pilkonis, 1977). In social interactions (Arkowitz, Lichtens, Mcgovern, & Hines, 1975; Clark & Arkowitz, 1975; Glasgow & Arkowitz, 1975; Hofmann, et al., 1997; Strahan & Conger, 1998) and in delivery of a speech (Hofmann, et al., 1997; Pilkonis, 1977; Rapee & Lim, 1992; Voncken & Bögels, 2008), the number of studies favouring a social skill deficit are almost as many as those not favouring.

4.1 Emotion Regulation in Social Anxiety

Recently, clinical research focused on emotion and emotion regulation in SAD and how treatments can improve emotion regulation (Jazaieri, Morrison, Goldin, & Gross, 2015). Even though also high-functioning individuals experience social anxiety, the amount of social anxiety individuals with SAD experience is highly impairing (Bögels, et al., 2010). An emotion dysregulation might cause this extreme fear of negative evaluation. Indeed, studies have indicated that poor or inflexible emotion regulation is associated with or possibly even causal for the development of anxiety disorders (Blair & Coles, 2000; Eisenberg et al., 2001).

As previously explained, Gross (2002) uses a broad definition of emotion regulation, with a focus not only on response-focused but also on antecedent focused strategies. In SAD *situation selection* involves the avoidance of feared social and performance situations that resemble situations they have encountered in the past (Anderson, Goldin, Kurita, & Gross, 2008). Avoidance is positively associated with psychopathological symptoms like anxiety, depression, eating and substance related disorders (Aldao et al., 2010). According to the two-factor learning theory of Mowrer (1951), avoidance is responsible for the maintenance of anxiety. In social or performance situations, *situation modification* can become operative. Mostly patients with SAD engage in safety behaviours that contribute to the maintenance of anxiety (Wells et al., 1995). The enhanced attention to sources of potential threat (Bar-Haim et al., 2007) represents a form of *attentional deployment*. *Cognitive change* is one of the main targets of CBT for SAD (Heimberg, 2002) because difficulties employing reappraisal are considered a core mechanism in the maintenance of psychopathology in individuals with anxiety disorders (Campbell-Sills, & Barlow, 2007). Deficient cognitive reappraisal processes in SAD can be restored, when appropriate training is employed (Goldin, Manber-Ball, Werner, Heimberg, & Gross, 2009). As the appraisal individuals experience in a specific situation is influenced by ones interpretation of the situation, social cues are of special

importance. In Interactions, facial expressions serve as important cues of how others evaluate us (Leber, Heidenreich, Stangier, & Hofmann, 2009), and therefore chapter 4.3 looks at the perception of these in more detail.

Expressive suppression could be a form of *response modulation*, whereby individuals inhibit outward expressions of an emotion such as facial behaviour. Research suggests that patients with SAD suppress both negative (Erwin, Heimberg, Schneier, & Liebowitz, 2003) and positive emotions (Turk, Heimberg, Luterek, Mennin, & Fresco, 2005). Suppression often leads to less warm and outgoing behaviour, which may in turn elicit less friendly behaviours (even rejection) from others, which subsequently generates negative emotions (Clark, & Wells, 1995). Furthermore, expressive suppression could lead to an inhibition of emotional mimicry reactions.

SAD seems indeed to be characterized by high levels of maladaptive forms of emotion regulation such as expressive suppression, and relatively low levels of generally adaptive forms of emotion regulation such as cognitive reappraisal (Goldin, et al., 2009; Goldin, Manber, Hakimi, Canli, & Gross, 2009). According to Goldin et al. (2014) these differences are caused by suppression being less effortful, more familiar, and requiring less skill than reappraisal, as well as SAD patients having a greater wish to hide visible physiological indicators of anxiety (e.g., blushing, trembling, sweating) which they interpret as signs of weakness and vulnerability.

Several studies investigated emotion regulation in SA according to the model suggested by Gratz and Roemer (2004). Patients with SAD compared to controls previously reported more difficulties identifying and describing feelings (Cox, Swinson, Shulman, & Bourdeau, 1995; Fukunishi, Kikuchi, Wogan, & Takubo, 1997; Turk et al., 2005). One reason for difficulties in identifying emotions could be a lack of awareness. Indeed, high socially anxious (HSA) individuals have been found to pay less attention to their emotions than low socially anxious (LSA) individuals (Turk et al., 2005). In addition, HSA individuals indicated a poorer ability to access effective emotion regulation strategies (Mennin, McLaughlin, & Flanagan, 2009; Rusch, Westermann, & Lincoln, 2012), impulse control difficulties (Rusch et al., 2012), and problems accepting their emotions (Mennin et al., 2009; Rusch et al., 2012). Furthermore, HSA individuals expressed less positive emotions than LSA individuals (Turk et al., 2005). If these emotion regulation deficits are causal to social anxiety remains object of further investigations.

In conclusion, emotion dysregulation seems to be a prominent problem in individuals with SAD. Fortunately, these emotion regulation processes can be enhanced with cognitive

behavioural therapy, for example by fostering cognitive reappraisal frequency and self-efficacy (Goldin et al., 2012; Goldin et al., 2014). However, as maladaptive emotion regulation strategies are better predictors of social anxiety than adaptive strategies (Aldao, Jazaieri, Goldin, & Gross, 2014), therapy should not only focus on the acquisition of adaptive emotion regulation strategies, but also on the attenuation of maladaptive ones.

4.2 Emotional Mimicry in Social Anxiety

To our knowledge, only one group has investigated mimicking behaviour and social anxiety. Vrijssen, Lange, Becker, and Rinck (2010) found that HSA individuals showed less observed mimicry of the head movements of a computerized avatar in comparison to LSA individuals. Emotional mimicry, however, has so far not been investigated in HSA individuals, but in people with fear of public speaking, a specific aspect of the more generalized concept social anxiety. People with high fear of public speaking show less mimicry of happy expressions than people with low fear (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004). The results for the mimicry of angry expressions, in contrast, were inconsistent. Whereas Dimberg and Christmanson (1991) found less mimicry, others found higher mimicry in individuals high in fear of public speaking (Dimberg, 1997; Dimberg & Thunberg, 2007; Vrana & Gross, 2004). Furthermore, individuals high in fear of public speaking showed more negative facial affects in reaction to neutral faces, which was interpreted as an anxiety reaction (Vrana & Gross, 2004).

It is, however, difficult to compare the results of these studies because Dimberg and colleagues (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007) usually calculated difference scores between anger and happiness, while Vrana and Gross (2004) used the absolute muscle activity for each emotion. Moreover, Dimberg (1997) used a median split of the sample based on a questionnaire on fear of public speaking, while other studies (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004) used the highest and lowest 10–28% of students on such a questionnaire. Furthermore, while mood can affect emotional mimicry, none of the studies controlled for mood. Moreover, the stimuli used in the studies so far were only static pictures of emotional faces, but dynamic images have been shown to elicit a larger mimicry effect (Sato, Fujimura, & Suzuki, 2008). Additionally only pictures of adults were used, but emotional mimicry is stronger in reaction to pictures of people of the same age (Ardizzi et al., 2014).

4.3 Emotion Recognition in Social Anxiety

So far, studies on emotion recognition in SAD that examined the recognition of various facial emotional expressions have obtained mixed results. Some results suggest that there are no significant differences in recognition accuracy between individuals with SAD and healthy controls (Arrais et al., 2010; Bell et al., 2011; Campbell et al., 2009; Joormann & Gotlib, 2006; Philippot & Douilliez, 2005; Stevens, Gerlach, & Rist, 2008) and between HSA and LSA individuals (Leber et al., 2009). Hunter, Buckner, and Schmidt (2009) found a generally enhanced recognition of facial expressions in HSA compared to LSA individuals. Other studies found an enhanced recognition of negative compared to positive facial expressions in individuals with SAD (Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Lundh & Ost, 1996) and of negative compared to neutral facial expressions in HSA but not in LSA individuals (Winton, Clark, & Edelman, 1995). Thus, previous studies have tended to produce evidence against impaired emotion recognition. Some methodological issues have to be considered that might influence emotion recognition. Most of the mentioned studies used black-and-white static stimuli (Arrais et al., 2010; Campbell et al., 2009; Joormann & Gotlib, 2006; Leber et al., 2009; Philippot & Douilliez, 2005; Winton et al., 1995). Presentation times of the facial expressions varied from 60 ms (Leber et al., 2009; Winton et al., 1995) to 30 s (Foa et al., 2000) or were self-paced (Arrais et al., 2010), and therefore the results are difficult to compare. The two studies using dynamic facial expressions (Bell et al., 2011; Joormann & Gotlib, 2006) used presentation times longer than 25 s, which can look unnatural and produce results unrepresentative of daily life, because facial expressions typically change within seconds. Furthermore, previous studies did not control for mood, but mood can influence emotion recognition (Mullins & Duke, 2004).

Interestingly, in children, SAD was associated with impaired emotion recognition (Battaglia et al., 2004; Simonian, Beidel, Turner, Berkes, & Long, 2001), only one study failed to find any effect of SA (McClure & Nowicki, 2001). In children, Melfsen and Florin (2002) found a generally higher rate of misinterpretations of neutral faces as positive and negative. In conclusion, only studies with children but not with adults with SAD provide evidence for an emotion recognition deficit in individuals with SAD.

5. Nonsuicidal Self-Injury

5.1 NSSI and Clinical Correlates

One important aspect of a new distinct entity that is also relevant for diagnostic validity is its delimitation in respect to other disorders (Feighner et al., 1972). Nock, Joiner, Gordon, Lloyd-Richardson, and Prinstein (2006) and Hintikka et al. (2009) investigated diagnostic correlates in adolescents with NSSI behaviour. The most common Axis I disorders in adolescents with NSSI behaviour were major depressive disorder, conduct disorder, and PTSD (Nock et al., 2006, Hintikka et al., 2009). Clinical correlates indicate that patients with NSSI behaviour have, as found in studies of diagnostic correlates, elevated depression as well as externalizing and borderline symptomatology (Crowell et al., 2012; Csorba, Dinya, Plener, Nagy, & Pali, 2009; García-Nieto, Carballo, Díaz de Neira Hernando, de León-Martinez, Baca-García, 2014; Selby, Bender, Gordon, Nock, & Joiner, 2012). Depressive symptoms even are a significant predictor of NSSI behaviour in future (Barrocas, Giletta, Hankin, Prinstein, & Abela, 2014; Rodav, Levy, & Hamdan, 2014). However, comparability of these studies is limited, as different definitions of NSSI were used, because the official criteria were not yet available (APA, 2013).

Another important yet difficult distinction has to be made between NSSI and suicidality. Both behaviours result in a self-inflicted injury. However, three key differences are noteworthy: First, most people engaging in NSSI have, per definition, no intent to die during the self-injuring act. Second, methods and injuries of NSSI are often less severe and usually the damage is not life threatening. Third, NSSI and suicide differ in the frequency of the act, as NSSI often occurs daily (Klonsky, Muehlenkamp, Lewis, & Walsh, 2011; Muehlenkamp & Gutierrez, 2007). Importantly, the differences between NSSI and suicidality do not preclude their co-occurrence. It is important to highlight that NSSI is a major risk factor for suicidality (Klonsky, May, & Glenn, 2013; Tuisku et al., 2014). Klonsky et al. (2013) found NSSI to be more strongly associated with a history of suicide attempts than other established risk factors for suicide, such as depression, anxiety, impulsivity, and BPD. Longitudinal studies show that NSSI is a significant predictor for suicidal behaviour, probably even a stronger predictor than a history of past suicide attempts (Guan, Fox, & Prinstein, 2012). Most people engaging in NSSI report suicidal ideation (Asarnow et al., 2011; Whitlock et al., 2013). In the study by Nock et al. (2006), 74% of the adolescents with NSSI reported having attempted suicide at least once in the past 6 months. However, the nature of this relationship remains ambiguous. According to the theory of acquired capability for

suicide, engagement in NSSI may reduce inhibitions around self-inflicted violence, imparting greater risk for suicide attempts among those with suicidal ideation than would be observed in those who do not have a history of NSSI. In line with this, NSSI frequency is strongly associated with suicidal ideation, plans and attempts (Andover & Gibb, 2010; Paul, Tsypes, Eidlitz, Ernhout, & Whitlock, 2015). Furthermore, individuals with a history of suicide attempts report significantly more NSSI functions than those without. Specifically, nearly every NSSI function was significantly related to suicide attempts, with functions “avoiding committing suicide”, “coping with self-hatred”, and “feeling generation” (anti-dissociation) showing the strongest risks for suicide attempts (Paul et al., 2015).

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 (Bresin, 2014; Muehlenkamp, Peat, Claes, & Smits, 2012).

In conclusion, NSSI behaviour is associated with a high internalizing and externalizing psychopathology, a high suicidality, as well as with emotion dysregulation. It remains object of further investigations, if the same pattern can be replicated in adolescents with NSSI disorder.

5.2 NSSI and Personality

Due to the inclusion of nonsuicidal self-injury (NSSI) in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; section 3; APA, 2013) as a distinct disorder a differentiation between adolescents with NSSI disorder with and without comorbid borderline personality disorder (BPD) is required. Probably the assessment of specific personality traits may be able to make this differentiation and to help to identify persons at risk for the development of NSSI.

Linehan (1993) highlights the role of temperament in the development and maintenance of NSSI and BPD. Indeed, personality traits might be a relevant risk factor for NSSI (Nock, 2010; Hefti, In-Albon, Schmeck, & Schmid, 2012). In line with this, a highly harmful temperament profile in patients with BPD was identified, comprised of high harm avoidance and novelty seeking (Barnow, Ruege, Spitzer, & Freyberger, 2005; Cloninger & Svrakic, 1997; Ha et al., 2004; Joyce et al., 2003; Kaess et al., 2013; Pukrop, 2002). Increased harm avoidance in adolescence even predicted BPD in adults (Arens, Grabe, Spitzer, & Barnow, 2011). According to Cloninger, Praybeck, and Svrakic (1994), this personality pattern consisting of high novelty seeking and high harm avoidance represents an approach-avoidance conflict that may cause affective instability, a core feature of BPD.

As only a minority of adolescents with NSSI suffers from BPD (In-Albon et al., 2013; Schmid, Schmeck, & Petermann, 2008; Zlotnick, Mattia, & Zimmermann, 1999), studies with adolescents with NSSI without BPD are needed to validate the link between this personality pattern and NSSI. Higher levels of *novelty seeking* were found in adolescents with self-injurious behavior (SIB) compared to those without SIB (Hefti et al., 2013). Furthermore, depressive adolescents patients with self-injurious behavior reported more *harm avoidance* than those without SIB (Joyce, Light, Rowe, Cloninger, & Kennedy, 2010). However, none of these studies controlled for comorbid BPD. Adolescents with NSSI not fulfilling BPD criteria report more borderline personality symptoms than adolescents without NSSI, raising the question if personality disorders should rather be viewed as a dimensional and not categorical construct. In fact, *DSM-5* describes an “Alternative Model for Personality Disorders” (APA, 2013) consisting of a dimensional and categorical construct of personality functioning or psychopathology.

Among different personality concepts Cloninger’s (1987) biopsychosocial personality model seems to be able to describe healthy as well as pathological personality traits, and to differentiate between patients with and without personality disorders (Herpertz et al. 2006, Schmeck et al. 2013). Cloninger’s (1987) biopsychosocial personality model divides personality into temperament, viewed as stable (Goldsmith et al., 1987) and heritable (Cloninger et al., 1994), and character, influenced by sociocultural learning (Cloninger, Svrakic & Przybeck, 1993). As shown in Table 1, the model includes four temperament (novelty seeking, harm avoidance, reward dependence, persistence) and three character dimensions (self-directedness, cooperativeness, self-transcendence). According to Cloninger (2000), personality disorders are characterized by low levels of self-directedness, cooperativeness, and self-transcendence; at least for low self-directedness and low cooperativeness evidence exists (Svrakic et al., 1993). Low *self-directedness* is related to adult depression (Richter & Eisemann, 2002), to BPD in adolescents (Barnow et al., 2005; Kaess et al., 2013) and to SIB in adolescents (Hefti et al., 2013; Joyce et al., 2010). Low *cooperativeness* is associated with aggressive and delinquent behaviour (Kim et al., 2006). A higher cooperativeness was found in female adolescents with SIB compared to those without SIB (Ohman et al., 2008), whereas adolescents with BPD showed lower cooperativeness than control adolescents (Barnow et al., 2005). High *self-transcendence* is linked to SIB in adolescents (Hefti et al., 2013) and to BPD in adolescents (Barnow et al., 2005). Low *reward dependence* is linked to internalizing symptoms like depression and anxiety (Kim et al., 2006), but no association has been found between reward dependence and SIB (Hefti et al.,

2013; Joyce et al., 2010; Ohmann et al., 2008). Kaess et al. (2013) found a lower reward dependence in adolescents with BPD than in clinical and healthy controls. *Persistence* is neither linked to BPD (Barnow et al., 2005; Kaess et al., 2013) nor to SIB (Hefti et al., 2013; Joyce et al., 2010; Ohmann et al., 2008).

Table 1

Temperament and character dimensions (Cloninger, 1999)

	Dimension	High level	Low level
Temperament	Novelty Seeking	Curious, impulsive, sensation seeking	Indifferent, thoughtful, modest
	Harm Avoidance	Worried, pessimistic, frightened, shy	Relaxed, optimistic, fearless, confident, talkative
	Reward dependence	Sensitive, warm, dependent	Cold, secluded, independent
	Persistence	Hard-working, ambitious, perfectionist	Inactive, lethargic, pragmatic
Character	Self-directedness	Mature, effective, responsible, determined, high self-acceptance	Immature, unreliable, indecisive, low self-acceptance
	Cooperativeness	Social tolerant, empathic, helpful	Social intolerant, critical, cold, not helpful, destructive
	Self-transcendence	Experienced, patient, creative, self-forgetting, connected to the universe, spiritual	Uncomprehending, proud, unimaginative, lack of humility,

In sum, previous research is consistent with the notion that heritable temperament traits are underlying features of BPD symptoms. However, it remains unclear, if the same pattern can be found in a sample of adolescents with NSSI disorder without BPD. According to previous studies, adolescents with NSSI most likely show a pattern of high novelty seeking, self-transcendence and harm avoidance and lower values on self-directedness compared to nonclinical controls (Hefti et al., 2013; Joyce et al., 2010; Ohmann et al., 2008). However, none of the presented studies assessed NSSI according to the *DSM-5* criteria (Hefti et al., 2013; Joyce et al., 2010; Ohmann et al., 2008). Thus, the samples were heterogeneous. Whereas Hefti et al. (2010) investigated a school sample, Joyce et al. (2010) investigated depressed adolescents with and without SIB, and Ohmann et al., 2008 investigated a clinical population of in- and outpatients. To our knowledge, previous studies investigated neither

personality traits in adolescents with a NSSI disorder (according to DSM-5), nor differences in personality between adolescents with NSSI with and without BPD.

5.3 NSSI and BPD

A clear differentiation between NSSI and BPD is needed. Self-injurious behaviour is one of nine symptoms of BPD in the *DSM-IV-TR* criteria (American Psychiatric Association [APA], 2000). However, although NSSI and BPD can co-occur, they also occur independently. Several studies indicated that only about 50% of those who engage in NSSI suffer also from BPD (Herpertz, 1995; Selby, et al., 2012; Zlotnick, Mattia, & Zimmerman, 1999). However, since diagnostic criteria for NSSI were not yet available, these studies used different incomparable definitions of NSSI. For example the criterion that NSSI has to be executed repeatedly (on 5 or more days in the last year) was not assessed. In a retrospective chart review, Selby et al. (2012) compared treatment-seeking adult outpatients who engaged in NSSI with a group of adults suffering from BPD as well as a comparison group with various Axis I diagnoses. The NSSI and BPD groups had similar levels of impairment and a similar psychopathology. The NSSI group was characterized by higher depressive symptoms, anxiety, and suicidality than the clinical comparison group. Interestingly, most subjects of the NSSI group did not exhibit sub threshold BPD symptoms. Although no information was available about the frequency and motivation for NSSI, results indicated that NSSI had the potential of being a separate diagnostic entity. In addition, NSSI reflects clinically significant impairment regardless of whether BPD is also present (Glenn & Klonsky, 2013) and differences in the functions of self-injury between patients with BPD and self-injurers without BPD have been shown; self-injuring adolescents with BPD endorsed more items reflecting self-punishment, anti-suicide, and anti-dissociation functions (Bracken-Minor & McDevitt-Murphy, 2014). Adolescents with NSSI and BPD show more emotion regulation difficulties than adolescents with NSSI without BPD, but for both groups the affect regulation function was the most highly endorsed (Bracken-Minor & McDevitt-Murphy, 2014). In conclusion, there are some similarities between adolescents with NSSI and adolescents with BPD, but there are also important differences.

5.4 NSSI and Impulsivity

Recent research and theory suggest that highly impulsive individuals may be especially motivated to act rashly in the context of negative emotions because long-term benefits become less important than short-term gains of emotion regulation (e.g., The Theory of Urgency, Cyders & Smith, 2008; also see Tice, Bratslavsky, & Baumeister, 2001). Given that

NSSI is an effective way for individuals to regulate aversive emotions (Armey et al., 2011; for a review see Klonsky, 2007), impulsive individuals may be at high risk for NSSI engagement. 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. NSSI has been found to link with many other impulsive behaviours, including frequent antisocial behaviours, alcohol consumption, smoking, and drug use (De Leo & Heller, 2004; Hilt, Nock, Lloyd-Richardson, & Prinstein, 2008). NSSI itself is often an impulsive act, as most of the individuals with NSSI think less than five minutes before committing the act (Nock & Prinstein, 2005). Therefore, impulsivity might explain the difficulties patients with NSSI have to resist the urge to injure themselves (Glenn & Klonsky, 2010), and could be particularly responsible for the high suicidality in patients with NSSI (Klonsky et al., 2013), as impulsivity is a common risk factor for suicidal behaviour (Gvion & Apter, 2011). Indeed, recent findings suggest that the link between impulsivity and suicidal behaviour may actually be mediated by NSSI engagement (Anestis, Tull, Lavender, & Gratz, 2014). Furthermore, impulsivity is associated with greater emotion regulation difficulties in young adults (Schreiber, Grant, & Olaug, 2012), a problem often endorsed in adolescents with NSSI (Bresin, 2014; Muehlenkamp et al., 2012).

Impulsivity stands for a spectrum of behaviours and is often divided into attentional impulsivity (inability to focus/concentrate on something), motor impulsivity (acting without thinking of consequences) and non-planning impulsivity (lack of future orientation and foresight) (Barratt, 1959). Indeed, individuals with NSSI report higher impulsivity than individuals without NSSI (for a review see Hamza, Willoughby, & Heffer, 2015), and patients with repetitive NSSI reported even higher impulsivity than patients with onetime NSSI (Evans, Platts, & Liebenau, 1996). A recent study by You, Lin and Leung (2015) found that behavioural impulsivity also made an additional contribution to predict future engagement in NSSI above and beyond those of BPD features, negative emotions, and previous NSSI.

However, previous research has found low convergence between self-report and behavioural measures of impulsivity (Enticott, Ogloff, & Bradshaw, 2006; Gerbing, Ahadi, & Patton, 1987). Therefore, it seems important not only to investigate self-report measures, but also scrutinize behavioural tasks. Response inhibition, an aspect of impulsivity, can be measured with a Go/No Go task and refers to the ability to halt the execution of an already initiated action (Nigg, 2000). Janis and Nock (2009) compared self-reported impulsiveness with experimentally assessed impulsiveness in adolescents with NSSI behaviour. While participants with NSSI scored higher on self-reported impulsiveness, they did not differ from

the comparison group on behavioural measures. This result has been replicated in studies with adolescents (Fikke, Melinder, & Landro, 2011) and adults (Glenn & Klonsky, 2010; Mc Closkey, Look, Chen, Pajoumand, & Berman, 2012). Notably, these studies did not assess response inhibition to emotional stimuli, which may partially explain the nonsignificant differences. A recent study by Allen & Hooley (2015) found adolescents with NSSI to show difficulties in response inhibition in response to images with negative, but not positive or neutral emotional content in comparison with a healthy control group. Interestingly, adolescents with NSSI showed an enhanced performance in response inhibition in reaction to images of NSSI. The self-injuring group may find NSSI images less aversive, and therefore less disruptive of response inhibition, due to habituation, or perhaps the history of positive reinforcement associated with self-injury (Franklin et al., 2014).

Another explanation for the difference between self-reported and experimentally assessed impulsivity may be explained by the measurement of different impulsivity constructs. While self-report questionnaires measure general response tendencies (traits), behavioural tasks may rather measure spontaneous reactions that are influenced by current cognitive processes (Mc Closkey et al., 2012). Self-report questionnaires usually assess impulsivity in the context of negative emotions, but so far, lab-based studies have not included mood manipulations prior to assessing behavioural measures of impulsivity (for a review see Hamza et al. 2015). Differences may not emerge between individuals with and without NSSI until participants are asked to perform the task under conditions of distress. Self-injurers might only experience heightened impulsivity under emotional distress in real life situations. Supporting this hypothesis, Bresin, Carter, and Gordon (2013) found that sadness, in particular, interacted with impulsivity to predict NSSI urges in their daily diary study.

5.5 NSSI and Emotion Recognition

Misinterpretations of emotional facial displays in social situations are likely to result in emotional disturbances, inadequate social behaviour, lack of social skills, and less adaptive social problem-solving skills, problems often observed in adolescents with NSSI behaviour (Nock & Mendes, 2008; Claes et al., 2010). Thus, social, emotional, and problem-solving skills include identifying emotions in others. To our knowledge, there is no study on emotion recognition abilities in adolescents with NSSI. As some adolescents with NSSI meet the criteria for borderline personality disorder (BPD), in the following, we will refer to morphing studies with subjects with BPD. In adolescents with BPD, results on emotion recognition are

inconsistent. Von Ceumern-Lindenstjerna et al. (2007) asked female adolescents with BPD to name the displayed emotion by using a self-report questionnaire on the perception of emotions in facial expressions. Results indicated no deficits in naming the displayed emotions. Jovev et al. (2011) described no differences in emotional sensitivity in adolescents with subsyndromic features of BPD compared to healthy controls, yet Robin et al. (2012) investigated adolescents with BPD and showed a lower sensitivity to facial emotions of anger and happiness, but no impairment in identifying fully expressed emotions. Both studies used dynamic facial expressions; however, they used the adult, black-and-white Ekman and Friesen (1976) pictures. Results of studies with adult participants with BPD are also inconsistent. Lynch et al. (2006) reported a greater sensitivity to facial expressions, whereas Domes et al. (2008) reported no differences. See also Domes, Schulze, and Herpertz (2009) and Mitchell, Dickens, and Picchioni (2014) for a review on emotion recognition in BPD. Mitchell et al. (2014) concluded that despite methodological differences, no significant recognition impairment between BPD and healthy controls for any negative emotion was revealed. As a limitation, the specificity of the findings to BPD has been questioned, as all the studies compared BPD only to healthy controls. The above-mentioned studies recruited adolescents with BPD or BPD features. However, only a minority of patients with NSSI disorder (In-Albon et al., 2013) and adults with NSSI behaviour (Selby et al., 2012) meet the criteria for BPD. Another issue to consider is that the subject's current mood influences facial emotion recognition, as emotional states alter how people respond to faces (Chepenik, et al., 2007; Mullins & Duke, 2004). The information-processing theory proposes that mood affects perception and attention (Dodge, 1991). This has been shown in various studies. For example, Lee et al. (2008) indicated that for participants in a sad mood, their mood had an influence on facial recognition such that they tended to classify ambiguous as negative, and Chepenik et al. (2007) showed that sad mood interfered with facial emotion recognition. However, these studies investigated adults from community samples. Studies with a clinical sample of adolescents examining the effect of a mood induction on emotion recognition are still missing.

6. Aims of the Thesis

Given the high prevalence rates of NSSI in adolescent community samples (4–6%; Muehlenkamp, Brausch, Quigley, & Whitlock, 2013; Zetterqvist et al., 2013) and inpatient samples (over 40%; Glenn & Klonsky, 2013; Kaess, et al., 2012), combined with the high rates of comorbidity and the low functioning, it is essential to gain more insight into the nature of NSSI. The fact that NSSI is a major risk factor for suicidality (Klonsky, et al., 2013; Tuisku et al., 2014) strengthens even more the need to develop adequate treatments for individuals with NSSI. Since nowadays a definition for NSSI exists and diagnostic criteria for the *DSM-5* (APA, 2013) are defined, the basis for a profound investigation of this behaviour is set.

Linehan's biosocial theory on the development of BPD conceptualizes NSSI as an emotion regulation strategy. This conceptualization is supported by both empirical and theoretical literature focusing on the functions of this behaviour (Briere & Gil, 1998; Gratz, 2003). NSSI is often used as a maladaptive coping strategy for intense emotions resulting from intra- and interpersonal difficulties (Nock, 2010). Furthermore, social interaction problems are often a trigger for NSSI (Nock & Mendes, 2008). As social interaction problems can have their origin in emotion recognition difficulties, it is important to investigate, if individuals with NSSI have impaired emotion recognition. To date paradigms investigating emotion recognition are rare. Therefore we developed our own paradigm and tested it in a group of students, chosen for being either high or low in social anxiety. The investigation of the recognition of emotional facial expressions in social anxiety seems to be important because facial expressions contain information about negative evaluations by others (Leber et al., 2009), one of the main fears of individuals with social anxiety (APA, 2013). A better understanding of emotion perception and emotion regulation in high socially anxious individuals might be an important step in developing more successful treatments for SAD. For clinicians, it is important to know if patients with SAD have deficits in social skills and therefore might benefit from social skills trainings. In a review, Levitan and Nardi (2009) stated that patients with SAD performed worse in social interactions and were rated by observers as less assertive and friendly, but when specific social skills were measured typically no difference between patients with SAD and healthy controls could be detected. Maybe the social skills deficits are subtle and have not yet received sufficient scrutiny by research. An altered facial mimicry pattern could be responsible for the observed difficulties

in social interactions. To face this deficit in facial mimicry would require specific interventions, such as emotion recognition and expression training.

Therefore, besides testing our emotion recognition paradigm, our goal with the pre-study was to investigate if social anxiety is related to altered emotional mimicry, emotion recognition, and emotion regulation. We hypothesized based on emotion regulation questionnaire data that HSA individuals would show more emotion regulation deficits and an altered pattern of emotional mimicry compared to LSA individuals. We expected to find further evidence for the emotional mimicry effect, not only for anger and happiness, but also for the less frequently investigated emotions anxiety, sadness, and disgust. Given the results of previous studies, we did not expect a substantial difference between the groups in emotion recognition.

Regarding NSSI, the aim of our first paper was to investigate the proposed diagnostic criteria for the *DSM-5*. As yet, there have been precious few empirical studies investigating diagnostic and clinical correlates using the proposed *DSM-5* criteria for NSSI and therefore little data supporting the validity of the criteria. Thus, our aim was threefold: first, to investigate the proposed diagnostic criteria for NSSI for the *DSM-5* using a clinical interview with inpatient female adolescents; second, to examine the diagnostic and clinical correlates of adolescents with NSSI disorder; and third, to compare adolescents with NSSI disorder with adolescents with no mental disorders, adolescents with mental disorders without NSSI, and subgroups of adolescents with NSSI such as adolescents with NSSI who did not report impairment or distress. We hypothesized that adolescents with NSSI disorder can be differentiated from other clinical and non-clinical groups, that adolescents with NSSI disorder would be more likely to have a history of suicide attempts, would have more comorbid diagnoses and score higher on self-reported psychopathology, especially borderline symptoms, and would have difficulties in emotion regulation and be more impaired in global functioning compared with the other groups.

The aim of our second paper was to shed more light onto the difference between NSSI and BPD by investigating personality functioning, to improve the process of finding indications for different treatments. Second, it is important to compare temperament and character traits of NSSI to a clinical (CC) and a nonclinical control group (NC), for the examination of how specific these traits are for individuals with NSSI. NSSI was assessed according to the *DSM-5* research criteria and personality traits were assessed according to Cloninger's (1987) model for personality. Taking the results of previous studies into account, we hypothesized that adolescents with NSSI show higher values on novelty seeking, self-

transcendence and harm avoidance and lower values on self-directedness compared to NC and CC. Previous research results regarding cooperativeness and NSSI are inconsistent, therefore we analyzed group differences. As one part of novelty seeking, impulsivity was further investigated using a self-report questionnaire and a Go/No Go task.

In our third study, we finally focused on emotion recognition and evaluation in adolescents with NSSI. The functional approach to understand NSSI has received much attention and support (see Bentley, Nock, & Barlow, 2014 for a review). Whereas the automatic mechanisms have been widely investigated (Klonsky, 2011; Nock, 2010), social functions are both understudied and underreported in comparison with the automatic functions (Nock, 2008; Bentley et al., 2014). Bentley et al. (2014) suggested that researchers should consider the employment of objective measures (e.g., facial emotion recognition) of specific interpersonal skills in studies on NSSI to investigate observed problems with a range of communication skills in individuals with NSSI. Results may inform preventive and treatment efforts for individuals with NSSI.

In addition to the more objective measure of facial emotion recognition using a morphing paradigm, we obtained a dimensional rating of the facial expressions in terms of valence and arousal. To our knowledge there is no study investigating the valence and arousal of facial expressions in adolescents with NSSI disorder. Therefore, the aim of the present study was to investigate recognition of dynamic emotional facial expressions in a sample of female adolescents with NSSI disorder, a clinical control sample and a nonclinical control sample, to consider the influence of a sad and a neutral mood on emotion recognition, and to obtain a dimensional rating of valence and arousal. Given that theoretically, emotion recognition is seen as a precursor to emotion regulation and emotion regulation is impaired in adolescents with NSSI, we hypothesized that adolescents with NSSI have more difficulties recognizing facial expressions, with respect to the mean percentage of stages viewed before the first correct response or in decoding accuracy, that is, in the overall number of emotions recognized. Given the previous inconsistent results on the type of misinterpretation, we did not formulate any firm directional hypotheses with respect to misinterpretations. However, we did predict a decline in emotion recognition, mean percentage of stages before the first correct response, and accuracy when a sad mood was induced compared to a neutral mood.

7. Methods

Two different studies were conducted. The pre-study was designed to test the facial mimicry paradigm. The aim of the main study was to investigate diagnostic criteria, underlying personality traits and examine emotion recognition in adolescents with NSSI.

7.1 Pre-study: Emotion Regulation in Social Anxiety

7.1.1 Participants

Seventy-four subjects were invited from a pool of 143 subjects screened with the Liebowitz Social Phobia Scale (LSAS; Stangier & Heidenreich, 2005). Subjects were chosen for either the HSA group from those scoring in the top 25% or the LSA group from those scoring in the bottom 25%. Forty-one of the invited subjects participated in the experiment (HSA: $n = 20$; LSA: $n = 21$). The groups were comparable with respect to sex (LSA: 14 female, 6 male; HSA: 16 female, 5 male), $\chi^2(1) = 0.20, p = .66$, and age (LSA: $M = 25.75$ years, $SD = 6.31$; HSA: $M = 25.87$ years, $SD = 7.53$), $t(39) = -0.06, p = .96$. To confirm group differences in social anxiety symptoms indicated with the LSAS, $U = 420, p < .01$, participants in the experiment also completed the Social Interactions Anxiety Scale (SIAS; Mattick & Clarke, 1998; German translation: Stangier, Heidenreich, Berardi, Golbs, & Hoyer, 1999), which measures anxiety in social situations and interactions, as well as the Social Phobia Scale (SPS; Mattick & Clarke, 1998; German translation: Stangier et al., 1999), which specifies the subtype of social phobia and measures anxiety in performance situations. As shown in table 2, HSA participants scored significantly higher on the SIAS, $U = 390, p < .01$, and the SPS, $U = 392, p < .01$, than LSA participants. Six HSA participants on the SIAS (Mattick & Clarke, 1998; German translation: Stangier et al., 1999) and eight on the SPS (Mattick & Clarke, 1998; German translation: Stangier et al., 1999) had values above the clinical cut-off, as did all 20 HSA participants on the LSAS (Stangier & Heidenreich, 2005), using a cut-off score of 30 as suggested by Rytwinski et al. (2009).

Table 2

Clinical Correlates of Low Socially Anxious (LSA) and High Socially Anxious (HSA) Participants, as well as Mann–Whitney U-Test Results

Measure	LSA <i>M (SD)</i>	HSA <i>M (SD)</i>	<i>U</i>
SIAS	11.15 (5.01)	26.67 (10.61)	390**
SPS	3.55 (2.06)	17.71 (9.80)	392**
LSAS	8.00 (2.25)	54.62 (13.18)	420**

Note. SIAS = Social Interactions Anxiety Scale, SPS = Social Phobia Scale, LSAS = Liebowitz Social Phobia Scale. ** $p < .01$.

7.1.2 Mood Induction and Emotional State

To ensure that all participants were in a similar, neutral mood before taking part in the experiment, we showed them part of a documentary on stars (03 min 22 sec) that has shown its efficacy in mood induction (Bolten & Schneider, 2010). After the film and after the mimicry paradigm participants indicated their current emotional state (arousal, excitement, anxiety, happiness, tension, sadness) on a 7-point Likert scale (1 = *not at all*, 7 = *very much*).

7.1.3 Emotion Regulation Measure

To assess difficulties in emotion regulation the *Difficulties in Emotion Regulation Scale* (DERS; Ehring, Tuschen-Caffier, Schnulle, Fischer, & Gross, 2010; Gratz & Roemer, 2004) was used. The measure yields a total score and scores on six subscales (nonacceptance of emotional responses, difficulties engaging in goal-directed behaviour, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, lack of emotional clarity). The internal consistency within the present sample was $\alpha = .92$ for the total score, and for the subscales it ranged from $\alpha = .73$ to $.87$.

7.1.4 Facial Mimicry Task

Stimuli. The facial stimuli were taken from the NimStim Face Stimulus Set (www.macbrain.org; Tottenham et al., 2009). Using a morphing technique similar to that in Sato and Yoshikawa (2007) 60 facial expressions changing in 50 steps from a neutral expression to full-intensity emotion [happiness, sadness, anger, anxiety, disgust, neutral (i.e., no change, as a control condition)] were created using WinMorph 3.01. Each stimulus was

presented for 140 ms with the software E-Prime (version 2.0) to create the impression of an animated clip of the progression of an emotional facial expression lasting 7 s.

Physiological measures. Electromyography (EMG) was performed according to the guidelines of Fridlund and Cacioppo (1986). The activity of the following muscles was recorded on the left side of the face: *m. corrugator supercilii*, *m. frontalis medialis*, *m. levator labii*, and *m. zygomaticus major*. As mentioned above, sufficient evidence exists only for the emotional mimicry effect of anger and happiness with their corresponding muscles *m. corrugator supercilii* (Dimberg, 1982) and *m. zygomaticus major* (Hjortsjö, 1970), and not for disgust, which is usually indexed by *m. levator labii* activity (Lundqvist & Dimberg, 1995) and anxiety, which should be related to *m. frontalis medialis* activity (Moody et al., 2007). More evidence exists for the imitation of sadness, but this emotion is also indexed by *m. corrugator supercilii* activity and hence it is unclear whether the displayed emotion is anger or sadness. Activation of this muscle can signal a negative mood, concentration, or bewilderment (Larsen, Norris, & Cacioppo, 2003). Therefore, we decided to measure the imitation of sadness with the *m. frontalis medialis*, similar to the procedure followed by Cram and Criswel (2010).

The measurement of the physiological data was conducted with a separate computer with the software AcqKnowledge (Biopac Systems, Inc., Goleta, CA, USA, 2003). Ag-Ag/Cl miniature electrodes filled with electrolyte were used for the recordings. The EMG was sampled at 1,000 Hz after anti-aliasing low-pass filtering at 500 Hz. To measure muscle activity magnitude, a 50-Hz notch filter, a high-pass filter (25 Hz), and, after signal rectification, a moving average filter with a window length of 50 ms were applied offline using ANSLAB software (Autonomic Nervous System Laboratory, version 4.0; Wilhelm & Peyk, 2005).

7.1.5 Procedure

The study was approved by the local ethics committee. All participants were informed of their rights as research participants and gave their written informed consent in accordance with the Declaration of Helsinki. They received course credit or a cinema voucher for their participation. Participants were seated in front of a computer and all physiological equipment was attached. The neutral mood induction film was shown. Afterward participants indicated their current emotional state. Then six practice trials (including all six emotions) were conducted. Before each morphing sequence of facial expressions (7,000 ms), a fixation cross appeared for 500 ms. After

each morphing sequence a white screen appeared for 2,000 ms. Then participants were presented with a rating screen asking them to identify the emotion as happiness, sadness, anger, disgust, anxiety, or neutral. Before the start of a new sequence a white screen was shown for 2,000 ms. All six emotions were shown with five female and five male actors in a randomized order, which totals 60 sequences. The task took approximately 40 min. After the task participants indicated their current emotional states again. Electrodes were removed and participants were asked to complete the questionnaires.

7.1.6 Data Reduction and Statistical Analysis

To analyse the EMG data, each continuous file was first visually inspected for noise and artefacts using ANSLAB (Wilhelm & Peyk, 2005). During EMG data acquisition, facial movements such as yawning were marked and subsequently excluded. EMG data were used to calculate facial responses to stimuli. The prestimulus window was 500 ms before the onset of the pictures; poststimulus muscle activity was averaged in 500-ms bins. The prestimulus value was subtracted from the poststimulus values to calculate facial reactivity as change from baseline. Values were standardized within participants and within muscles in order to allow meaningful comparisons across muscles and participants. Finally, we computed mean levels of activity for each muscle and each type of emotion. For statistical analyses, the first 2 s poststimulus were dropped because in the dynamic facial stimuli, emotional expression was too subtle to be detectable and visual data inspection showed only minimal EMG effects. To evaluate mimicry effects, data were analysed with a 2 (Group: HSA vs. LSA) \times 2 (Emotion: target emotion vs. neutral face) \times 10 (Time: from Second 2 of the stimuli presentation to the end in 500-ms bins) repeated-measures analysis of variance (ANOVA) for each emotion (cf. Moody et al., 2007). To ensure that participants did not react to the neutral stimuli in a specific way, we first calculated a 2 (Group: HSA vs. LSA) \times 4 (Muscle: *m. corrugator supercilii*, *m. frontalis medialis*, *m. levator labii*, *m. zygomaticus major*) \times 10 (Time: from Second 2 of the stimulus presentations to the end in 500-ms bins) repeated-measures ANOVA only for neutral stimuli. If the assumption of sphericity was violated, Greenhouse–Geisser correction was used. For additional correlational analyses, we calculated a mimicry index for every emotion using the mean values for every target emotion minus the mean values for the neutral emotion.

7.2 Main Study: Adolescents with Nonsuicidal Self-injury

Because data collection is still ongoing, sample sizes vary to a large extent. Furthermore, different samples were used to address different research questions. For example, adolescents with repetitive NSSI but who denied being impaired or distressed (NSSI-C group) were only used to examine the diagnostic and clinical correlates of NSSI.

7.2.1 Participants

Participants were female adolescents aged between 13-18 years and recruited from different inpatient psychiatric units in Switzerland and Germany. Participants included adolescents who fulfilled the proposed *DSM-5* criteria for NSSI disorder (NSSI group), adolescents who fulfilled the proposed *DSM-5* criteria for NSSI disorder and the *DSM-IV* criteria for BPD (NSSI+BPD group), adolescents with NSSI who denied being impaired or distressed by their NSSI (NSSI-C group), adolescents with a *DSM-IV* diagnosis other than NSSI (CC group), and non-clinical adolescents (NC group) who did not have a current or past experience of a mental disorder. The NSSI-C group indicated in the diagnostic interview repetitive NSSI but negated the questions on impairment and distress in different settings such as family, school or leisure. In addition, they denied questions such as if the patient has to hide the wounds and scars in daily life, if the patient thinks about possible long term consequences of the behaviour, and how difficult it would be to stop from one day to the other with NSSI. Since the inpatient clinics were responsible for the recruitment of the clinical groups, we do not have any access to the demographic and clinical characteristics of patients that were excluded by the clinics. Our predefined exclusion criteria were current or past psychosis or schizophrenic symptoms.

Sample Characteristics Main Study 1: Diagnostic and Clinical Correlates of NSSI

In total, 110 participants were tested, 41 of these participants were included in the NSSI group, 12 in the NSSI-C group, 20 CC group, and 37 NC group. The NSSI-C group was the only subgroup of self-injuring adolescents that could be used for further analyses, because the sample sizes of other subgroups were too small. Demographic and psychosocial characteristics of this sample are reported in Table 3. The samples differed with respect to age ($F = 6.14, p < .01$). Post hoc analysis indicated that this effect was mainly due to the younger age of the non-clinical adolescents group.

Table 3

Demographic and Psychosocial Characteristics of Adolescents with NSSI Disorder (NSSI), Compared with Non-Clinical Adolescents (NC), Clinical Controls Without NSSI (CC), and Adolescents with NSSI Without Impairment/Distress (NSSI-C)

Characteristic	NC (<i>n</i> = 37)	CC (<i>n</i> = 20)	NSSI-C (<i>n</i> = 11)	NSSI (<i>n</i> = 39)	Statistics
Mean age (SD) in years	14.60 (1.02)	15.93 (1.52)	17.08 (1.92)	15.94 (1.42)	F (3, 33.36) = 12.19**
Mean no. of school years (SD)	8.40 (1.08)	9.25 (1.58)	9.33 (1.41)	9.16 (1.10)	F (3, 79) = 2.88*
Number (percentage) living with parents ^a	31 (100)	15 (93.8) ^a	11 (100)	26 (83.9) ^b	χ^2 (9) = 10.2
Number (percentage) whose parents have joint custody ^b	31 (86.1)	12 (75.0)	7 (70.0)	20 (66.7)	χ^2 (9) = 8.04

Note. * $p < .05$, ** $p < .01$. ^aOne was in another child and adolescent psychiatric clinic, three children lived in a supervised residential group, one in a foster family, and one in another child and adolescent psychiatric clinic, ^bthe rest had mothers with sole custody.

Sample Characteristics Main Study 2: Personality in Adolescents with NSSI

Out of the 167 individuals with a mean age of $M = 15.94$, $SD = 1.47$, 57 were in the NSSI group (without BPD), 14 in the NSSI+BPD group, 32 in the CC group, and 64 in the NC group. Participants were similar with respect to age, Welch's $F(3, 47.19) = 0.41$. Psychosocial characteristics are reported in Table 4. Regarding nationalities, most of our participants were Swiss and German, except for two Italians, one Thai and one Pole. The three most frequent mental disorders in all groups were major depression (37.50% in CC group, 70.18% in NSSI group, 78.6% in NSSI+BPD group), social phobia (34.38% in CC group, 36.84% in NSSI group, 42.9% in NSSI+BPD group), and specific phobia, (28.13% in CC group, 19.30% in NSSI group, 35.70% in NSSI+BPD group). Posttraumatic stress disorder was a common comorbid disorder in NSSI group (14.04%) and NSSI+BPD group (50%), only two participants of the CC group suffered from PTSD (6.25%). Groups differed significantly regarding depression, $\chi^2(2) = 11.87$, $p < 0.01$, and PTSD, $p < 0.01$, according to a two-sided Fisher's exact test. There were no significant differences regarding any other *DSM-IV* disorders assessed with the clinical interviews. Further comorbid diagnoses of the clinical groups were dysthymia, oppositional defiant disorder, ADHD, conduct disorder, bulimia nervosa, anorexia nervosa, obsessive-compulsive disorder, agoraphobia, panic disorder, and

generalized anxiety disorder. Groups did significantly differ regarding the number of diagnoses $F(2, 100) = 30.37, p < 0.01$, patients in the NSSI+BPD group met significantly more diagnoses than the other groups ($M = 5.43, SD = 1.83$), NSSI group met significantly more diagnoses ($M = 3.39, SD = 1.36$) than clinical controls ($M = 2.03, SD = 1.00$).

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Table 4

Mean (Standard Deviations) of Characteristics of Non-Clinical adolescents (NC), Clinical Controls without NSSI (CC), Adolescents with NSSI Disorder (NSSI), and Adolescents with NSSI and BPD (NSSI+BPD), as well as ANOVA with Orthogonal Contrasts and Effect Sizes (Cohen's d) Between Non-Clinical and Clinical Groups (NC vs. Rest), Clinical Controls and NSSI (CC vs. NSSI and NSSI+BPD), and NSSI Disorder vs. BPD (NSSI vs. NSSI+BPD).

Characteristic	NC <i>M (SD)</i>	CC <i>M (SD)</i>	NSSI <i>M (SD)</i>	NSSI+BPD <i>M (SD)</i>	NC vs. rest <i>t</i> (139)	CC vs. NSSI total <i>t</i> (139)	NSSI vs. NSSI+BPD <i>t</i> (139)
YSR	(<i>n</i> = 57)	(<i>n</i> = 28)	(<i>n</i> = 47)	(<i>n</i> = 11)			
total	57.60 (18.70)	81.80 (21.60)	105.38 (29.97)	134.28 (22.40)	12.56**	7.04**	4.03**
YSR ext ^a	9.79 (6.56)	12.38 (6.45)	17.47 (9.15)	30.76 (7.82)	6.77**	4.58**	3.50**
YSR int	9.83 (6.46)	23.68 (9.56)	32.49 (9.53)	41.18 (8.68)	14.66**	6.22**	3.10**
BDI ^b	7.02 (7.20)	21.89 (12.68)	33.40 (12.17)	43.20 (13.29)	13.17**	4.70**	1.82
JTCI	(<i>n</i> = 51)	(<i>n</i> = 26)	(<i>n</i> = 46)	(<i>n</i> = 11)	<i>t</i> (130)	<i>t</i> (130)	<i>t</i> (130)
Novelty seeking (T) ^a	47.29 (8.20)	43.00 (8.62)	48.20 (11.61)	56.00 (8.31)	0.66	3.42**	2.39*
Harm avoidance (T)	49.33 (10.18)	59.38 (8.59)	61.35 (11.10)	69.64 (8.51)	7.32**	2.34*	2.44*
Reward dependence (T)	57.06 (8.37)	52.04 (9.20)	49.96 (10.77)	45.91 (12.03)	-4.18**	-1.64	-1.24
Persistence (T)	50.22 (10.21)	53.73 (9.93)	45.09 (11.74)	35.27 (9.70)	-2.71**	-4.92**	-2.74**
Self-directedness (C)	52.22 (10.41)	43.88 (10.45)	33.22 (11.70)	26.73 (9.81)	-8.51**	-4.97**	- 1.78
Cooperativeness (C)	53.75 (8.89)	56.88 (9.21)	54.93 (11.77)	46.27 (9.70)	-0.54	-2.41*	-2.56*
Self-transcendence (C)	49.43 (9.58)	53.92 (10.68)	50.02 (9.12)	50.82 (11.81)	1.15	-1.38	0.24
Impulsivity (BIS)	(<i>n</i> =28)	(<i>n</i> =21)	(<i>n</i> =29)	(<i>n</i> =8)	<i>t</i> (82)	<i>t</i> (82)	<i>t</i> (82)
Attentional	20.76 (3.15)	20.06 (3.47)	22.97 (3.94)	26.85 (2.78)	2.99**	4.70**	2.78**
Nonplanning	15.61 (4.01)	14.90 (3.16)	18.25 (4.10)	20.88 (1.89)	2.67**	4.34**	1.77
Motor	25.52 (4.33)	24.59 (5.13)	27.47 (5.76)	34.63 (5.07)	2.72**	4.27**	3.51**
Motor	21.16 (3.96)	20.70 (3.97)	23.21 (6.90)	25.04 (4.04)	1.46	2.24*	0.89

Note. YSR = Youth Self Report (ext = externalizing, int = internalizing), BDI = Beck Depression Inventory-II; JTCI = Junior Temperament and Character Inventory; BIS = Barratt Impulsiveness Scale. * $p < 0.05$, ** $p < 0.01$.^aLog transformation, ^bsquare root transformation.

Sample Characteristics Main Study 3: Emotion Recognition in Adolescents with NSSI

Out of the 126 adolescents, 47 were in the NSSI group, 28 in the CC group, and 51 in the NC group. Demographic and psychosocial characteristics of adolescents in the NSSI, CC, and NC groups are reported in Table 5. The most common comorbid diagnosis of the adolescents with NSSI was major depression (33 patients, 70.2%), followed by social phobia (18 patients, 38.3%) and specific phobia (10 patients, 21.3%). Thirteen adolescents fulfilled criteria for BPD and were excluded from the analyses so we could restrict the results to NSSI. The most frequent diagnosis in the CC group was also major depression (10 patients, 35.7%) followed by social phobia (10 patients, 35.7%) and specific phobia (7 patients, 25%). Significantly more patients with NSSI than clinical controls fulfilled the criteria for major depression, $\chi^2(1) = 9.28$, $p < 0.01$, whereas significantly more clinical controls than patients with NSSI fulfilled the diagnosis obsessive-compulsive disorder, $p < 0.01$, according to a two-sided Fisher's exact test. There were no significant differences regarding any other *DSM-IV* disorders assessed with the clinical interviews. Patients with NSSI met significantly more diagnoses ($M = 3.36$, $SD = 1.37$) than clinical controls ($M = 2.00$, $SD = 1.09$), $t(68.00) = 4.74$, $p < 0.01$.

Table 5

Demographic Characteristics and Clinical Correlates of Adolescents with NSSI (NSSI), Clinical Controls (CC), and Non-Clinical Controls (NC), as well as Analysis of Variance Results and Group Comparisons (C)

Characteristic	NSSI <i>M (SD)</i>	CC <i>M (SD)</i>	NC <i>M (SD)</i>	<i>F</i>	<i>C</i>
Mean age (<i>SD</i>) in years	16.04 (1.29)	15.91 (1.38)	15.36 (1.59)	2.78	1, 2, 3
Questionnaire					
YSR total ^a	2.01 (0.09)**	1.89 (0.10)**	1.71 (0.15)**	60.42**	1 > 2 > 3
YSR ext ^a	1.17 (0.25) **	1.03 (0.18) *	.86 (0.33)**	13.91**	1 > 2 > 3
YSR int ^b	32.34 (9.18)**	23.71 (9.86)**	9.15 (6.89)**	80.96**	1 > 2 > 3
BDI-II	33.95 (12.20)**	21.16 (13.22)**	7.02 (7.72)**	75.93**	1 > 2 > 3
BSL-95	182.56 (68.71)**	116.27 (74.56)**	45.88 (28.32)**	60.91**	1 > 2 > 3

Note. YSR = Youth Self-Report, int = internalizing, ext = externalizing; BDI-II = Beck Depression Inventory-II; * $p < 0.05$; ** $p < 0.01$; ^alog transformed; ^bsquare root transformed

7.2.2 Procedure

All participants and their parents were informed about the study and provided their written consent in accordance with the Declaration of Helsinki. The local ethics committee approved the study. The diagnostic interviews and questionnaires were completed prior to commencing the Go/No Go task, afterwards the facial morphing task was administered. Participants were paid 40 Swiss francs upon completion of the tasks.

7.2.3 Measures

Assessment of Axis I and Axis II diagnoses. To examine the participants' current or past *DSM-IV-TR* diagnoses for Axis I disorders, we conducted a structured interview. The *Diagnostic Interview for Mental Disorders in Children and Adolescents* (Kinder-DIPS; Schneider, Suppiger, Adornetto, & Unnewehr, 2009) assesses the most frequent mental disorders in childhood and adolescence (all anxiety disorders, depression, ADHD, conduct disorder, sleep disorders, eating disorders). We included substance use disorders and borderline personality disorder from the adult DIPS (Schneider & Margraf, 2006). The Kinder-DIPS has good validity and reliability for axis I disorders (child version, $kappa = 0.48-0.88$; Adornetto, In-Albon, & Schneider, 2008; Neuschwander, In-Albon, Adornetto, Roth, & Schneider, 2013). NSSI was assessed using the proposed *DSM-5* criteria from 2012. The proposed criteria as of 2012 and the final published version are comparable (see Table 6). The criteria were reformulated as questions. Interrater reliability estimates for the diagnosis of NSSI were very good ($kappa = 0.90$). Suicide attempts were also assessed at the end of the interview. Master's students in clinical child psychology were first systematically trained in conducting the interviews.

Table 6

Proposed and Actual Diagnostic Criteria for Nonsuicidal Self-Injury (NSSI) for the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)^a

Proposed diagnostic criteria for nonsuicidal self-injury (NSSI) for the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5):

- A. In the last year, the individual has, on 5 or more days, engaged in intentional self-inflicted damage to the surface of his or her body, of a sort likely to induce bleeding or bruising or pain (e.g., cutting, burning, stabbing, hitting, excessive rubbing), for purposes not socially sanctioned (e.g., body piercing, tattooing, etc.), but performed with the expectation that the injury will lead to only minor or moderate physical harm.
-

The behaviour is not a common one, such as picking at a scab or nail biting.

- B. The intentional injury is associated with at least 2 of the following:
1. Psychological Precipitant: Interpersonal difficulties or negative feelings or thoughts, such as depression, anxiety, tension, anger, generalized distress, or self-criticism, occurring in the period immediately prior to the self-injurious act.
 2. Urge: Prior to engaging in the act, a period of preoccupation with the intended behaviour that is difficult to resist.
 3. Preoccupation: Thinking about self-injury occurs frequently, even when it is not acted upon.
 4. Contingent Response: The activity is engaged in with the expectation that it will relieve an interpersonal difficulty, or negative feeling or cognitive state, or that it will induce a positive feeling state, during the act or shortly afterwards.
- C. The behaviour or its consequences cause clinically significant distress or interference in interpersonal, academic, or other important areas of functioning. (This criterion is subject to final approval on the use of criteria that relate symptoms to impairment).
- D. The behaviour does not occur exclusively during states of psychosis, delirium, or intoxication. In individuals with a developmental disorder, the behaviour is not part of a pattern of repetitive stereotypies. The behaviour cannot be accounted for by another mental or medical disorder (i.e., psychotic disorder, pervasive developmental disorder, mental retardation, Lesch–Nyhan Syndrome, stereotyped movement disorder with self-injury, or trichotillomania).
- E. The absence of suicidal intent has either been stated by the patient or can be inferred by repeated engagement in a behaviour that the individual knows, or has learnt, is not likely to result in death.

Proposed diagnostic criteria for NSSI according to DSM-5 (APA, 2013):

- A. In the last year, the individual has, on 5 or more days, engaged in intentional self-inflicted damage to the surface of his or her body of a sort likely to induce bleeding, bruising, or pain (e.g., cutting, burning, stabbing, hitting, excessive rubbing), with the expectation that the injury will lead to only minor or moderate physical harm (i.e., there is no suicidal intent).

Note: The absence of suicidal intent has either been stated by the individual or can be inferred by the individual's repeated engagement in a behaviour that the individual knows, or has learned, is not likely to result in death.

- B. The individual engages in the self-injurious behaviour with one or more of the following expectations:
1. To obtain relief from a negative feeling or cognitive state.
 2. To resolve an interpersonal difficulty.
 3. To induce a positive feeling state.

Note: The desired relief or response is experienced during or shortly after the self-injury, and the individual may display patterns of behaviour suggesting a dependence on repeatedly engaging in it.

- C. The intentional self-injury is associated with at least one of the following:
-

-
1. Interpersonal difficulties or negative feelings or thoughts, such as depression, anxiety, tension, anger, generalized distress, or self-criticism, occurring in the period immediately prior to the self-injurious act.
 2. Prior to engaging in the act, a period of preoccupation with the intended behaviour that is difficult to control.
 3. Thinking about self-injury that occurs frequently, even when it's not acted upon.
- D. The behaviour is not socially sanctioned (e.g., body piercing, tattooing, part of a religious or cultural ritual) and is not restricted to picking a scab or nail biting.
- E. The behaviour or its consequences cause clinically significant distress or interference in interpersonal, academic, or other important areas of functioning.
- F. The behaviour does not occur exclusively during psychotic episodes, delirium, substance intoxication, or substance withdrawal. In individuals with a neurodevelopmental disorder, the behaviour is not part of a pattern of repetitive stereotypies. The behaviour is not better explained by another mental disorder or medical condition (e.g., psychotic disorder, autism spectrum disorder, intellectual disability, Lesch-Nyhan syndrome, stereotyped movement disorder with self-injury, trichotillomania [hair pulling disorder], excoriation [skin picking disorder]).

^aAs of November 2012, www.dsm5.org

Participants were administered the *Structured Clinical Interview for DSM-IV Axis II personality disorders* (SCID-II; Fydrich, Renneberg, Schmitz, & Wittchen, 1997) to assess personality disorders. The SCID-II was found to be suitable for use among adolescents (Salbach-Andrae et al., 2008). Interrater reliability for BPD in our sample was very good ($kappa = 1.00$). Before conducting the interviews all interviewers received an intensive standardized training.

The *Global Assessment of Functioning* (GAF; APA, 2000), assesses overall patient functioning and symptom severity; these characteristics have been reliably associated with clinical diagnosis, psychopathologic symptoms, and other clinical outcome ratings (Friis, Melle, Opjordsmoen, & Retterstol, 1993; Renneberg, Schmidt-Rathjens, Hippin, Backenstrass, & Fydrich, 2005).

The *Beck Depression Inventory-II* (BDI-II; Hautzinger, Keller, & Kühner, 2006), The BDI-II consists of 21 items and assesses depressive symptoms in adolescents. The internal consistency within the present sample was $\alpha = 0.96$.

The *Barratt Impulsiveness Scale* (BIS; Barrat, 1959; German version Hartmann, Rief, & Hilbert, 2011), is a widely used self-report questionnaire to assess impulsive personality traits with

three subscales: Attentional, motor, and nonplanning impulsivity. The BIS demonstrated good psychometric properties (Barrat, 1959; Hartmann et al., 2011). The internal consistency within the present sample was $\alpha = 0.81$.

The *Borderline Symptom List (BSL-95)* (Bohus et al., 2007), is a self-rating instrument for specific assessment of borderline-typical symptomatology. The symptomatology is collected for the last week. The BSL-95 includes 95 items that are based on *DSM-IV* criteria, the revised version of the Diagnostic Interview for Borderline Personality Disorder, and the opinions of both clinical experts and borderline patients. It consists of seven subscales assessing self-perception, affect regulation, self-destruction, dysphoria, loneliness, intrusions, and hostility. Within our sample the internal consistency for the subscales ranged from $\alpha = 0.84$ to 0.96. The internal consistency within the present sample for the total score was $\alpha = 0.98$.

The *Depression Anxiety Stress Scale (DASS-21)* (Köppe, 2001; Lovibond & Lovibond, 1995), is a reliable and valid self-report questionnaire comprising three scales measuring depression, anxiety, and stress. The internal consistency within the present sample was $\alpha = 0.93$ for the depression scale, 0.85 for the anxiety scale, 0.84 for the stress scale, and 0.94 for the total scale.

The *Functional Assessment of Self-Mutilation (FASM)* (Lloyd, Kelley, & Hope, 1997), is a self-report measure of the methods, frequency, and functions of NSSI. The internal consistency within our sample was $\alpha = 0.85$ for the overall scale.

The *Junior Temperament and Character Inventory (JTCI)* (Goth & Schmeck, 2009), is a self-report measure assessing the seven personality traits based on Cloningers (1987) bio-psycho-social model of personality. The questionnaire measures the scales novelty seeking, harm avoidance, reward dependence, persistence, self-directedness, cooperativeness and self-transcendence. The scales have good levels of internal consistency, with Cronbach's α ranging from 0.79 to 0.85 (Goth & Schmeck, 2009). The internal consistency within the present sample was $\alpha = 0.84$.

The *Questionnaire of Thoughts and Feelings (QTF)* (Renneberg et al., 2005), is a self-report scale (37 items) designed to measure borderline-specific basic assumptions and negative feelings. It is based on cognitive models and Linehan's biosocial model of BPD. The internal consistency within our sample was $\alpha = 0.97$.

The *Youth Self Report (YSR; Döpfner et al., 1994; Achenbach, 1991)* measures a broad range of psychopathology. Internal consistency within the present sample was $\alpha = 0.96$ for the total score, $\alpha = 0.94$ for the internalizing score, and $\alpha = 0.90$ for the externalizing score.

7.2.4 Non-Emotional and Emotional Go/No Go Task

Participants were instructed to press a button as adequate and as fast as possible if a Go stimulus appears on the screen and to suppress reactions to No Go stimuli. Participants had a test run with six trials, followed by the non-emotional Go/No Go task with 40 trials with “+” and “x” as Go and No Go. Afterwards participants completed an emotional Go/ No Go task with four combinations of angry, happy, and neutral facial expressions with 12 trials for each combination. The following six combinations were presented: x Go / + No Go, + Go / x No Go, Angry Go / Neutral No Go, Happy Go / Neutral No Go, Neutral Go /Angry No Go, Happy No Go/ Neutral Go. For all runs targets occurred on 50% of the trials. The order of the four emotional runs and the trials within each run were randomized across participants.

Facial stimuli consisted of colored angry, happy, and neutral expressions from 18 individuals (9 females) taken from the NimStim Face Stimulus set (Tottenham et al., 2009). Non-emotional stimuli (“+” and “x”) were presented for 200ms and emotional stimuli for 500ms, after a 500ms fixation cross. The interstimulus interval was 1.5 sec, in which a reaction was still possible. Stimuli were presented with E-Prime (Psychology Software Tools, Inc., Pittsburgh, PA, USA), and simultaneously omission (no reaction to Go) and commission (reaction to No Go) errors as well as reaction time were recorded. Omission errors indicate inattention (Trommer, Hoeppe, Lorber, & Armstrong, 1988), commission errors indicate response inhibition (Schulz et al., 2007), and reaction time to Go stimuli has previously been used as measure of response bias, with faster reactions indicating a response or attention-bias toward the shown emotion (Ladouceur et al., 2006).

7.2.5 Facial Morphing Task

Stimuli. The set of 60 faces was generated from the NimStim Face Stimulus Set (www.macbrain.org). The images contained happy, sad, angry, disgusted, fearful, and neutral expressions of 10 individuals (5 female, 5 male). The colour images were evaluated by young adults (Tottenham, et al., 2009). In addition, in a pilot study, we investigated 77 facial stimuli in

256 adolescents between 14 and 17 years of age. Results were similar to those of the original Tottenham et al. (2009) study. The mean percentage of correctly identified emotions was 80.79%. Happiness was identified best with 96.3%, and fear worst with 71.61%.

Design. We used the morphing technique from WinMorph 3.01 (www.debugmode.com/winmorph) to create 50 unique faces that changed in 2% steps from neutral to full emotion. Another 10 faces remained neutral but were manipulated to display small movements (opening and closing the mouth; the NimStim faces consist of neutral pictures with an open and a closed mouth). Each facial picture was presented for 100 ms using E-Prime software (Psychology Software Tools, Pittsburgh, Penn.), which creates the impression of an animated clip of the progression of an emotional facial expression. All six expressions (happiness, sadness, anger, disgust, fear, and neutral) were shown in each of seven trials, resulting in 42 sequences. The presentation of the pictures was randomized. Before each facial stimulus a fixation cross was shown for 500 ms. The sequences were shown in two blocks that were followed by a neutral and a negative mood induction (in randomized order). Each block consisted of 30 facial stimuli (6 emotions × 5 models). Subjects were instructed to watch the face change from neutral to an emotion and to press the space bar as soon as they recognized an emotion. After the participants pressed the space bar, the sequence stopped and they were presented with a rating screen asking them to identify the emotion as happiness, sadness, anger, disgust, fear, or neutral. The intensity of the emotion being expressed on the face when the participants pressed the space bar was recorded. Each participant participated in the task after a neutral and after a negative mood induction (in randomized order). Practice trials with all emotions were conducted.

Mood induction. Film clips are effective at inducing emotions (Silverman, 1986). Before completing the morphing paradigm, participants were shown in random order a brief sad or neutral film clip to induce a negative or neutral mood state. Sadness is a common emotion in adolescents with NSSI and a predictor of the urge to engage in NSSI (Bresin et al., 2013). Therefore, a sad mood induction was chosen. *My Girl* (Zeiff, 1991) depicts a girl learning that her best friend has died and was used for the negative mood induction. For the neutral mood induction part of a documentary on stars was shown. Both clips have shown their efficacy in mood induction (Bolten & Schneider, 2010; Joormann, Gilbert, & Gotlib, 2010). Following the film clip, participants were asked to think about how they would feel if they experienced the situation

they had just viewed. Before and after the mood induction, the present mood (sadness, happiness) was assessed on a 7-point Likert scale.

7.2.6 Ratings of Facial Expressions' Valence and Arousal

After the mood induction, each adolescent rated the set of 60 facial expressions with regard to their valence and arousal using the Self-Assessment Manikin, a pictorial 9-point scale (Bradley & Lang, 1994) ranging for valence from 1 (*very pleasant*) to 9 (*very unpleasant*), and for arousal from 1 (*very excited*) to 9 (*very calm*).

7.2.7 Data Analysis

For all statistical analyses significance levels were set at $\alpha = 0.05$. With regard to MANOVAs and ANOVAs, we applied the log or squared root transformation whenever Levene test indicated a violation of variance homogeneity. Moreover Greenhouse Geisser corrected values were used in the case of violation of sphericity.

Data Analysis Main Study 1: Diagnostic and Clinical Correlates of NSSI:

Logistic regression analyses were conducted to evaluate group differences on diagnoses. Independent variables were the group levels, and the dependent variables the disorders. As we were interested in specific group differences, we set up orthogonal comparisons. The first comparison contrasted the non-clinical adolescent group (NC) with the clinical groups (CC, NSSI, NSSI-C). The second comparison contrasted the clinical control adolescents (CC) with the two NSSI groups (NSSI and NSSI-C). The third comparison contrasted the two NSSI groups, that is, the NSSI and NSSI-C groups. Multivariate analyses of variance (MANOVAs) were used to compare the groups (NC, CC, NSSI-C, NSSI) on dependent variables such as internalizing and borderline symptoms, which were arranged based on content-wise criteria. One-way between-groups analyses of variance (ANOVAs) and effect sizes (Cohen's *d*) were used to assess differences in externalizing psychopathology (YSR external), general psychopathology (YSR total), global functioning (GAF), and difficulties in emotion regulation (DERS). The same orthogonal contrasts as described above were used to analyse group differences. For the comparison of self-injurious behaviour between the NSSI groups with and without impairment,

two MANOVAs were conducted, for the severity of NSSI (frequencies, number of methods) and functions of NSSI, respectively.

Data Analysis Main Study 2: Personality in Adolescents with NSSI

Multivariate analyses of variance (MANOVAs) were used to compare the groups (NC, CC, NSSI, NSSI+BPD) on dependent variables such as impulsivity and psychopathology. One-way between-groups analyses of variance (ANOVAs) and effect sizes (Cohen's d) were used to further analyse significant group differences of MANOVAs and for the questionnaires BDI-II and GSE. As we were interested in specific group differences, we set up orthogonal comparisons for psychopathology, personality, and self-reported impulsivity. The first comparison contrasted the non-clinical adolescent group (NC) with the clinical groups (CC, NSSI, NSSI+BPD), the second contrasted the clinical control group (CC) with the two NSSI groups (NSSI and NSSI+BPD), and the third contrasted the two NSSI groups, the NSSI and NSSI+BPD group.

For the Go/No Go task, a similar analysis strategy was used. First, outliers (z -values > 3) were excluded, then the sensitivity index d' ($z(\text{Reaction rate to Go}) - z(\text{Reaction rate to No Go})$) was calculated, as a measure of discrimination, with lower values representing an inability to distinguish between stimuli and lower performance levels (Pacheco-Unguetti, Acosta, Lupianez, Roman, & Derakshan, 2012). To examine group differences, the non-emotional Go/No Go task was evaluated with a one-way ANOVA, and the emotional Go/No Go tasks were analysed separately for emotional Go (neutral No Go) and for neutral Go (emotional No Go) with MANOVAs. This examination was done for the sensitivity index d' , errors of commission and omission, as well as for the reaction time on Go trials.

Data Analysis Main Study 3: Emotion Recognition in Adolescents with NSSI

The intensity scores of the facial expression at the time of the space bar press were analysed with a 3 (Group: NSSI, CC, NC) \times 6 (Emotion: happiness, sadness, anger, disgust, fear, neutral) \times 2 (Mood: neutral, sad) repeated-measures analysis of variance (ANOVA) with group as between-subjects factor and emotion and mood as within-subject factors. Similarly, analyses were conducted for group differences in the accuracy of emotion recognition and the valence and

arousal ratings of the stimuli. Post hoc Bonferroni-corrected contrasts were computed to assess the direction of the differences.

8. Summary of the Results

8.1 Pre-Study: Emotion Regulation in Social Anxiety

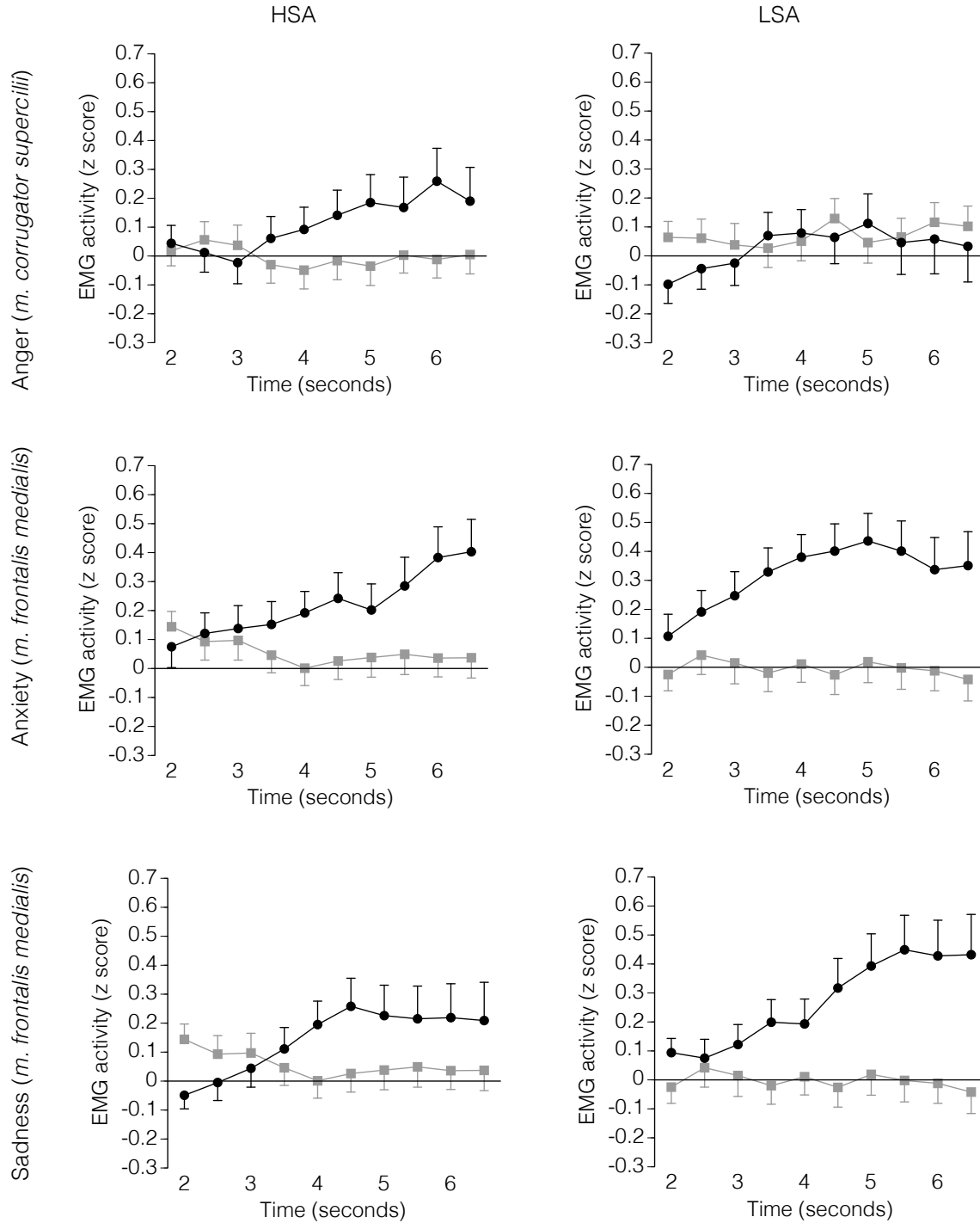
8.1.1 Emotional Mimicry

As expected, the ANOVA for the reaction to neutral faces (Group \times Muscle \times Time) yielded no significant interaction effects of Muscle \times Time \times Group, $F(9.60, 355.31) = .63, p = .78, \eta^2 = .02$, Muscle \times Time, $F(9.60, 355.31) = .88, p = .55, \eta^2 = .02$, Time \times Group, $F(3.92, 144.95) = 1.25, p = .29, \eta^2 = .03$, or Muscle \times Group, $F(2.04, 75.51) = 2.04, p = .14, \eta^2 = .05$, and no significant main effects of time, $F(3.92, 144.95) = 1.25, p = .29, \eta^2 = .03$, or group, $F(1, 37) = 1.13, p = .29, \eta^2 = .03$. However, there was a significant main effect of muscle, $F(2.04, 75.51) = 3.74, p = .03, \eta^2 = .09$. Whereas the *m. corrugator supercilii* and *m. frontalis medialis* indicated a slight activation in response to the neutral stimuli, the *m. zygomaticus major* and *m. levator labii* showed a slight deactivation.

Anger (*m. corrugator supercilii*). The mean data for the *m. corrugator supercilii* in response to angry expressions are presented in figure 2. Angry faces as compared to neutral faces tended to evoke greater *m. corrugator supercilii* activity over time, indicated by an Emotion \times Time interaction effect, $F(3.46, 131.41) = 3.97, p < .01, \eta^2 = .10$, and confirming the emotional mimicry effect. However, none of the other effects reached significance: Group \times Emotion \times Time, $F(3.46, 131.41) = 1.67, p = .17, \eta^2 = .04$; Group \times Time, $F(2.55, 97.07) = 0.61, p = .59, \eta^2 = .02$; Group \times Emotion, $F(1, 38) = 0.85, p = .36, \eta^2 = .02$; emotion, $F(1, 38) = 0.20, p = .66, \eta^2 = .01$, and group, $F(1, 38) = 0.01, p = .92, \eta^2 = .00$.

Anxiety (*m. frontalis medialis*). As visible in figure 2, anxious faces as compared to neutral faces evoked greater *m. frontalis medialis* activity over time, indicated by an Emotion \times Time interaction effect, $F(3.65, 138.59) = 8.04, p < .01, \eta^2 = .18$. The main effect of emotion, $F(1, 38) = 11.45, p < .01, \eta^2 = .13$, indicated that *m. frontalis medialis* activity was higher for anxiety than for neutral stimuli, and the main effect of time, $F(3, 113.85) = 2.94, p = .04, \eta^2 = .07$, indicated an increase over time. However, none of the other effects reached significance: Group \times Emotion \times Time, $F(3.65, 138.59) = 1.05, p = .38, \eta^2 = .03$; Group \times Time, $F(3, 113.85) = 2.09, p = .11, \eta^2 = .05$; Group \times Emotion, $F(1, 38) = 1.24, p = .27, \eta^2 = .05$; and group, $F(1, 38) = 0.09, p = .77, \eta^2 = .00$.

Figure 2. Average facial electromyography (EMG) activity in emotion-specific channels over 500-ms intervals during Seconds 2–7 for high socially anxious (HSA) and low socially anxious (LSA) groups: reactions to dynamic facial expression stimuli depicting anger, anxiety, and sadness.



Note. Grey line = neutral, black line = target emotion.

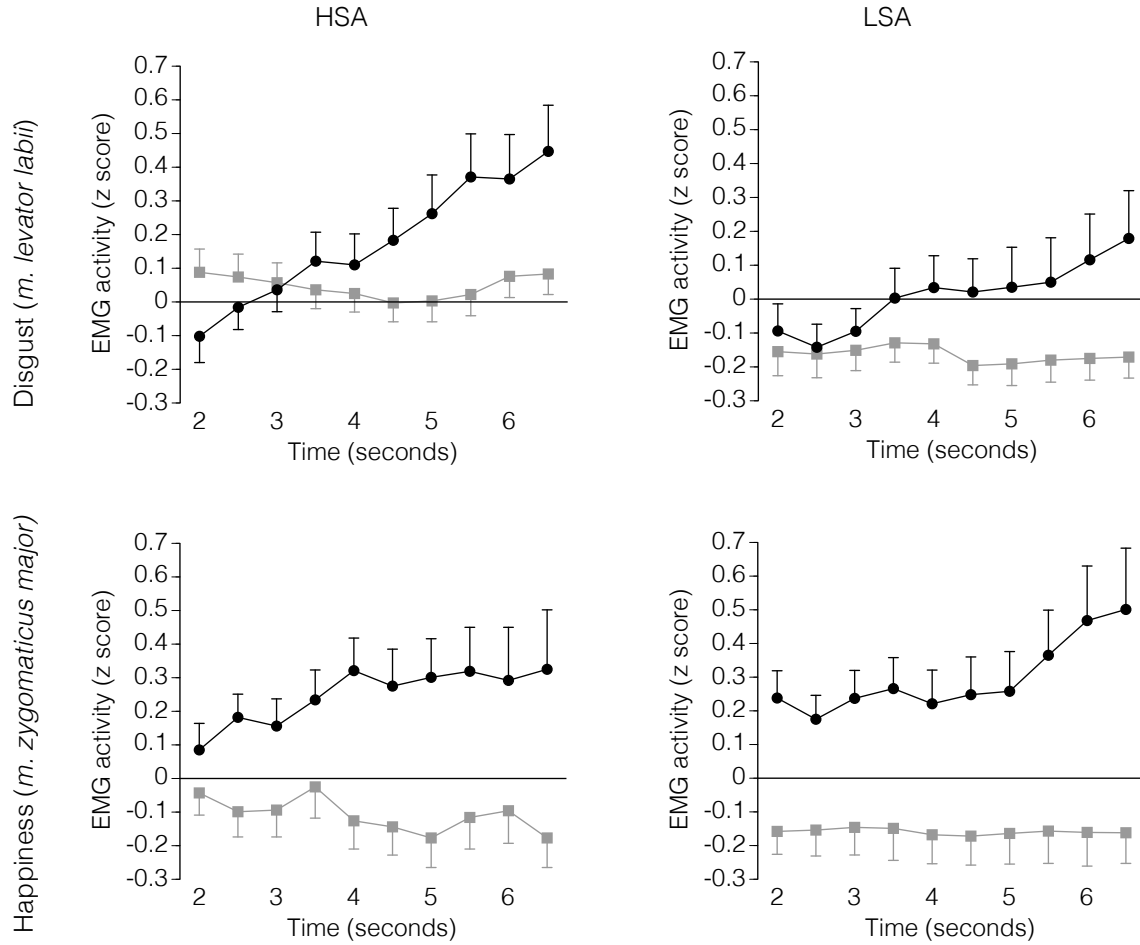
Sadness (*m. frontalis medialis*). The mimicry effect was shown by a significant Emotion \times Time interaction effect, $F(2.55, 96.71) = 9.53, p < .01, \eta^2 = .20$, and significant main effects of emotion, $F(1, 38) = 7.12, p = .01, \eta^2 = .16$, and time, $F(2.31, 87.64) = 4.80, p = .01, \eta^2 = .11$ (figure 2). None of the other effects reached significance: Group \times Emotion \times Time, $F(2.55, 96.71) = 1.16, p = .33, \eta^2 = .03$; Group \times Time, $F(2.31, 87.64) = 0.71, p = .51, \eta^2 = .02$; Emotion \times Group, $F(1, 38) = 1.96, p = .17, \eta^2 = .05$; and group, $F(1, 38) = 0.23, p = .63, \eta^2 = .01$.

Disgust (*m. levator labii*). There was a significant Emotion \times Time interaction effect, $F(2.43, 89.80) = 7.36, p < .01, \eta^2 = .17$, indicating a greater increase in *m. levator labii* activity for disgust stimuli than for neutral stimuli (figure 3). The main effect of time was significant, $F(3.04, 92.92) = 5.69, p < .01, \eta^2 = .13$, indicating an overall increase in *m. levator labii* activity over time. The main effect of emotion was just nonsignificant, $F(1, 37) = 3.97, p = .054, \eta^2 = .10$, the *m. levator labii* activation for disgust was higher than for the neutral emotion (figure 3). Furthermore, there was a significant main effect of group, $F(1, 37) = 10.46, p < .01, \eta^2 = .22$, indicating that HSA participants reacted with a higher *m. levator labii* activation not only to disgust faces, indicating a stronger mimicry, but also to neutral faces. There was no significant effect of Emotion \times Group, $F(1, 37) = .08, p = .78, \eta^2 = .00$; Time \times Group, $F(2.51, 92.92) = 1.02, p = .38, \eta^2 = .03$; or Emotion \times Time \times Group, $F(2.43, 89.80) = 0.83, p = .46, \eta^2 = .02$.

Happiness (*m. zygomaticus major*). Happy as compared to neutral faces tended to evoke overall greater *m. zygomaticus major* activity, indicated by a strong emotion main effect, $F(1, 37) = 18.29, p < .01, \eta^2 = .33$ (figure 3). There was also an Emotion \times Time interaction effect, indicating that the difference in activation between happy faces and neutral faces increased over time, $F(2.27, 83.85) = 3.51, p = .03, \eta^2 = .09$. None of the other effects reached significance: Group \times Emotion \times Time, $F(2.27, 83.85) = 1.35, p = .27, \eta^2 = .04$; Group \times Time, $F(2.15, 79.50) = 0.54, p = .60, \eta^2 = .01$; Group \times Emotion, $F(1, 37) = 0.30, p = .59, \eta^2 = .01$; time, $F(2.15, 79.50) = 1.80, p = .17, \eta^2 = .05$, and group, $F(1, 37) < 0.01, p = .97, \eta^2 = .00$.

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Figure 3. Average facial electromyography EMG activity in emotion-specific channels over 500-ms intervals during Seconds 2–7 for high socially anxious (HSA) and low socially anxious (LSA) groups: reactions to dynamic facial expression stimuli depicting disgust and happiness.



Note. Grey line = neutral, black line = target emotion.

8.1.2 Emotion Recognition

As reported in Table 7, participants decoded over 95% of the happy and neutral faces correctly. These two conditions were excluded from the analyses of group differences because of ceiling effects. The ANOVA for the percentage of correct responses with the within-subject factor emotion and the between-subjects factor group showed no significant Emotion \times Group interaction effect, $F(3, 117) = 0.32, p = .79, \eta^2 = .01$. There was a main effect of emotion, $F(3, 117) = 9.37, p < .01, \eta^2 = .19$, indicating that participants made more errors identifying anxiety and disgust than identifying anger and sadness. The main effect of group just failed to reach significance, $F(1, 39) = 3.51, p = .07, \eta^2 = .08$, with HSA participants showing a tendency toward a reduced recognition of facial expressions in general.

Table 7

Mean Percentage (Standard Deviation) of Emotion Recognition for Low Socially Anxious (LSA) and High Socially Anxious (HSA) Participants, as Well as Exploratory t-Test Results Comparing the Emotion Recognition Performance for Each Emotion Separately Between HSA and LSA

Emotion	LSA, $n = 20$ $M (SD)$	HSA, $n = 21$ $M (SD)$	$t (39)$	p
Anger	93.00% (8.01%)	90.95% (9.95%)	0.72	0.47
Anxiety	84.00% (13.92%)	77.62% (17.58%)	1.28	0.21
Disgust	81.00% (11.19%)	79.52% (12.44%)	0.40	0.69
Sadness	91.50% (8.12%)	87.62% (14.11%)	1.09	0.29
Neutral	94.50% (9.45%)	97.62% (6.25%)	-1.25	0.22
Happiness	100% (0%)	99.52% (2.18%)	0.98	0.34

8.1.3 Self-Reported Emotion Regulation

As shown in Table 8, the one-way ANOVAs yielded significant group differences for difficulties in emotion regulation (DERS), reflecting more self-reported difficulties in HSA than in LSA participants, $F(1, 39) = 13.19, p < .01, \eta^2 = .25$, as well as in its subscales nonacceptance, $F(1, 39) = 10.63, p < .01, \eta^2 = .21$; impulse control difficulties, $F(1, 39) = 11.10, p < .01, \eta^2 = .22$; lack of strategies, $F(1, 39) = 13.55, p < .01, \eta^2 = .26$; and lack of emotional clarity, $F(1, 39) = 10.36, p < .01, \eta^2 = .21$. There were no significant group differences in the DERS subscales goal attainment problems, $F(1, 39) = 1.90, p = .18, \eta^2 = .05$, or lack of awareness, $F(1, 39) = .02, p = .89, \eta^2 < .01$.

Table 8

Means (SD) and Group Comparisons of Self-Reported Emotion Regulation Facets Assessed With the Difficulties in Emotion Regulation Scale (DERS; Ehring et al., 2010; Gratz & Roemer, 2004)

DERS	Group		<i>F</i> (1, 39)
	LSA ^a	HSA ^b	
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	
Nonacceptance	9.07 (2.96)	12.90 (3.32)	10.63**
Goals	13.26 (4.28)	15.14 (4.45)	1.89
Impulse	8.80 (2.65)	12.10 (3.60)	11.10*
Awareness	13.55 (3.71)	13.71 (4.14)	0.02
Strategies	13.70 (4.14)	19.50 (5.73)	13.55**
Clarity	7.70 (1.63)	10.38 (3.36)	10.36**
Total	66.70 (13.69)	83.71 (16.14)	13.19**

Note. LSA = Low socially anxious; HSA = high socially anxious.

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

8.1.4 Mood

The 2 (Group: HSA vs. LSA) \times 2 (Time: before and after mimicry paradigm) \times 6 (Emotional state: anxiety, happiness, sadness, anger, excitement, and arousal) repeated-measures ANOVA revealed no significant interaction effect of Group \times Time \times Emotional state, $F(3.83, 149.49) = 0.67$, $p = .61$, $\eta^2 = .02$, Group \times Time, $F(1,39) < 0.01$, $p > .99$, $\eta^2 < .01$, or Time \times Emotional state, $F(3.83, 149.49) = 2.28$, $p = .07$, $\eta^2 = .06$. However, there was a significant interaction effect of Group \times Emotional state, $F(3.02, 117.57) = 4.41$, $p < .01$, $\eta^2 = .10$, with HSA participants experiencing more negative (excitement, arousal, sadness, anger) and less positive (happiness) emotions than LSA participants before and after the experiment. There was also a significant main effect of Group, $F(1,39) = 4.04$, $p = .05$, $\eta^2 = .09$, with HSA participants achieving higher values than LSA participants. Bonferroni-corrected post hoc comparisons indicated group main effects of excitement (HSA: $M = 2.76$, $SD = 1.07$; LSA: $M = 2.00$, $SD = 0.73$), $F(1,39) = 7.07$, $p = .01$, $\eta^2 = .15$, and arousal (HSA: $M = 3.12$, $SD = 1.27$; LSA: $M = 2.03$, $SD = 0.79$), $F(1,39) = 10.82$, $p < .01$, $\eta^2 = .22$, with HSA participants achieving higher values than LSA participants. Therefore, we calculated correlations of arousal and excitement with all outcome measures. All correlations between emotional mimicry and emotional state were nonsignificant; correlation coefficients

ranged between $r = -.07$ and $r = .03$ for excitement and between $r = -.19$ and $r = .02$ for arousal. There was no correlation of emotion recognition with excitement ($r = -.05$, $p = .76$) or with arousal ($r = -.14$, $p = .37$).

8.1.5 Additional Correlational Analyses

Emotion regulation difficulties (DERS total score) were negatively associated with the mimicry of anxiety, $r = -.37$, $p = .02$. There were no other significant correlations between emotional mimicry and emotion regulation difficulties. Overall emotion recognition performance was positively correlated with mimicry of anxiety, $r = .32$, $p = .04$. However, none of the other emotional mimicry effects correlated with emotion recognition. There was no significant association between emotion regulation and emotion recognition, $r = -.20$, $p = .22$.

8.2 Results Main Study 1: Diagnostic and Clinical Correlates of NSSI

8.2.1 Diagnostic Criteria of NSSI Disorder

The percentages of fulfilled B and C criteria for NSSI and the mean scores of frequency and strength of NSSI symptoms of adolescents with NSSI disorder and of adolescents with NSSI without impairment/distress are presented in Table 9. Data show that for the B criteria, psychological precipitant, frequent urges, and contingent responses were reported by at least 85% of the participants, whereas preoccupation with the behaviour and difficulty resisting the urge were reported by less than 50% of the participants. For the C criteria, impairment at leisure time was reported most frequently, and distress was indicated by 69% of the adolescents with NSSI disorder. The highest endorsement (79%) was to the question regarding desire for help, which was added to better operationalize the impairment/distress criteria. This question was also answered affirmatively by 30% of adolescents who denied experiencing impairment or distress due to NSSI.

Table 9

Frequency and Percentage of the Proposed B and C Diagnostic Criteria for NSSI for the DSM-5, of Adolescents with NSSI (NSSI) and Adolescents with NSSI without Impairment/Distress (NSSI-C)

Proposed criterion	NSSI (n = 39) No. (%)	NSSI Frequency ^a M (SD)	NSSI Strength ^b M (SD)	NSSI-C (n = 10) No. (%)
B1: Psychological precipitant	38 (97.4)			10 (100)
Sadness	30 (76.9)	2.29 (0.98)	2.38 (0.95)	7 (70.0)
Tension	29 (74.4)	1.82 (1.02)	1.89 (1.09)	5 (50.0)
Anger	24 (61.5)	1.68 (1.14)	1.69 (1.19)	6 (60.0)
Distress	23 (59.0)	1.66 (1.19)	1.70 (1.18)	5 (50.0)
Self-criticism	19 (48.7)	1.38 (1.18)	1.50 (1.23)	6 (60.0)
Anxiety	8 (20.5)	0.76 (1.13)	0.83 (1.12)	2 (20.0)
B2:				
Preoccupation with behaviour	18 (46.2)			7 (70.0)
Difficulties resisting the urge	15 (38.5)	2.47 (0.80)		4 (40.0)
B3: Urge occurs frequently	35 (89.7)	2.42 (0.72)	2.44 (0.64)	5 (50.0)
B4: Contingent response	34 (87.2)			7 (70.0)
Relief from negative feelings				
Before	10 (25.6)	0.63 (1.00)		4 (40.0)
During	14 (35.9)	1.00 (1.19)		3 (30.0)
After	21 (53.8)	1.66 (1.24)		7 (70.0)
Fewer interpersonal problems				
Before	2 (5.1)	0.15 (0.59)		2 (20.0)
During	5 (12.8)	0.35 (0.86)		2 (20.0)
After	4 (10.3)	0.34 (0.82)		3 (30.0)
Feel better				
Before	7 (17.9)	0.47 (0.98)		4 (40.0)
During	9 (23.1)	0.68 (1.12)		2 (20.0)
After	18 (46.2)	1.32 (1.32)		6 (50.0)
Reward				
Before	1 (2.6)	0.11 (0.52)		0 (0)
During	1 (2.6)	0.08 (0.50)		0 (0)
After	4 (10.3)	0.27 (0.80)		0 (0)
Preventing suicide attempt				
Before	7 (17.9)	0.94 (1.08)		1 (10.0)
During	6 (15.4)	0.38 (.87)		2 (20.0)
After	3 (7.7)	0.28 (.77)		0 (0)
C: Distress, Impairment				
Impairment	39 (100)	1.97 (0.77)		0 (0)
Home	9 (23.1)	0.94 (0.95)		0 (0)
School	8 (20.5)	0.94 (0.93)		0 (0)
Leisure time	13 (33.3)	1.12 (1.02)		0 (0)
Friends	10 (25.6)	0.88 (.99)		0 (0)
Distress	27 (69.2)			0 (0)
Want help:	31 (79.5)			3 (30)

Note. ^a Frequency scale 0-3 (0 = never, 1 = sometimes, 2 = often, 3 = very often) ^b Strength scale 0-3 (0 = not at all, 1 = a little, 2 = strong, 3 = very strong).

8.2.2 Symptoms of NSSI

The frequencies of each methods of self-injury used by the adolescents with NSSI and NSSI-C are presented in Table 10. A group differentiation between minor and moderate/severe methods was not possible, as 94% of the NSSI group and 82% of the NSSI-C group engaged in minor and moderate/severe methods.

Table 10

Frequency of Methods of Self-Injury Assessed by the FASM in Adolescents with NSSI (NSSI) and Adolescents with NSSI without Impairment/Distress (NSSI-C)

Method	NSSI (<i>n</i> = 33) No. (%)	NSSI-C (<i>n</i> = 11) No. (%)
Moderate/severe NSSI		
Cutting/carving on skin	32 (97.0)	9 (81.8)
Scraping	21 (63.6)	8 (72.7)
Burning skin	13 (39.4)	5 (45.5)
Rubbing skin to draw blood	9 (27.3)	3 (27.3)
Self-tattooing	3 (9.1)	1 (9.1)
Total moderate/severe methods	33 (100)	10 (90.9)
Minor NSSI		
Picking at a wound	24 (72.7)	7 (63.6)
Biting self	23 (69.7)	3 (27.3)
Hitting self	19 (57.6)	6 (54.4)
Inserting objects under skin or nails	9 (27.3)	0 (0)
Pulling out one's own hair	6 (18.2)	0 (0)
Picking areas of the body to the point of drawing blood	6 (18.2)	0 (0)
Total minor methods	31 (93.3)	10 (90.9)

Note. FASM = Functional Assessment of Self-Mutilation.

Table 11 shows the mean number of methods of NSSI performed, the experience of pain, the age of onset of NSSI, and received medical treatment. Further, group differences and effect sizes on severity and functions of NSSI are reported. There was no significant group effect for number of methods used, pain, and age of onset. Moreover, there was no significant group effect for the function of the NSSI behaviour, $F(4, 38) = 1.58, p = .20$, but the automatic negative

reinforcement, $F(1, 41) = 4.73, p = .035$, and positive reinforcement, $F(1, 41) = 6.41, p = .015$, were significantly more endorsed by the NSSI group compared with the NSSI-C group, which is also indicated by large effect sizes (Cohen's $d = 1.08, 1.21$).

Table 11

Means, Standard Deviations (SDs), and Effect Sizes (Cohen's d) of the FASM, in Adolescents with NSSI (NSSI) and Adolescents with NSSI without Impairment/Distress (NSSI-C)

FASM item	NSSI ($n = 33$) $M (SD)$	NSSI-C ($n = 12$) $M (SD)$	$F(1, 41)$	Cohen's d
No. of methods used	5.42 (2.18)	4.12 (2.00)	3.03	0.62
Pain ^a	3.18 (0.98)	2.91 (0.70)	0.72	0.32
Medical treatment by medical staff	No. 4 (12.1%)	No. 1 (8.3%)	$\chi^2 = 0.11$	
Age of onset (years)	13.05 (1.73)	13.00 (2.41)	0.01	0.02
Function			$F(4, 38) = 1.58$	
Automatic negative reinforcement	2.43 (0.84)	1.54 (0.81)	4.73*	1.08
Automatic positive reinforcement	2.08 (0.71)	1.33 (0.51)	6.41*	1.21
Social negative reinforcement	0.42 (0.48)	0.27 (0.34)	0.95	0.36
Social positive reinforcement	0.58 (0.37)	0.64 (0.58)	0.20	0.06

Note. ^aon a scale from 4 (no pain) to 1 (severe pain); * $p < .05$

8.2.3 Diagnostic Correlates

Axis I and II diagnoses for the clinical samples are reported in table 12. The mean number of diagnoses was 3.46 (SD = 1.80) for the NSSI group, 1.70 (SD = 1.2) for the CC group, and 2.09 (SD = 0.70) for the NSSI-C group. According to our data, NSSI was comorbid with other psychopathological disorders in all but two subjects (5%). Major depression was the most frequent comorbidity, followed by social phobia and PTSD. Logistic regression analyses indicated that major depression was significantly more prevalent (OR = 5.78, $p < .05$) among the NSSI group compared with the CC group. Table 12 shows odds ratios (ORs) and 95% confidence intervals for odds ratios for each diagnosis.

Adolescents with NSSI had relatively more diagnoses of PTSD and suicide attempts compared with the NSSI-C and CC groups. In our sample, eight adolescents (20.5%) with NSSI fulfilled the criteria for BPD. Adolescents with NSSI but not fulfilling diagnostic criteria for BPD endorsed a mean of 2.3 (SD = 1.56, range 0-4) symptoms of BPD. Most frequent symptoms were,

other than self-injurious behaviour, affective instability and inappropriate, intense anger. Least frequent symptoms were identity disturbances and paranoid ideation/severe dissociative symptoms.

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Table 12

Diagnostic Correlates of Adolescents with Clinical Diagnoses without NSSI (CC), Adolescents with NSSI without Impairment/Distress (NSSI-C), and Adolescents with NSSI (NSSI), as well as Logistic Regressions and Orthogonal Comparisons between Clinical Controls and NSSI (CC vs. NSSI) and between NSSI disorder and NSSI-C (NSSI vs. NSSI-C)

	CC (n = 20)	NSSI-C (n = 11)	NSSI (n = 39)	CC vs. NSSI	NSSI vs. NSSI-C
	N (%)	N (%)	N (%)	exp (b) = OR [95%CI]	exp (b) = OR [95%CI]
Major depression	6 (30)	8 (72.7)	31 (79.5)	5.78 [1.12 - 29.85]*	1.36 [0.29 - 6.34]
Social phobia	5 (25)	3 (27.3)	15 (38.5)	1.05 [0.20 - 5.60]	1.82 [0.41 - 8.00]
PTSD	1 (5)	2 (18.2)	11 (28.2)	4.00 [0.32 - 50.23]	1.90 [0.35 - 10.28]
BPD	0	0	8 (20.5)	NA	NA
Specific phobia	4 (20)	1 (9.1)	7 (17.9)	0.53 [0.05 - 5.86]	2.33 [0.26 - 21.36]
ODD	2 (10)	1 (9.1)	5 (12.8)	0.85 [0.07 - 10.61]	1.56 [0.16 - 15.00]
Bulimia Nervosa	0	0	5 (12.8)	NA	NA
Dysthymia	2 (10)	2 (18.2)	4 (10.3)	1.89 [0.23 - 15.74]	0.55 [0.09 - 3.47]
Conduct disorder	0	0	4 (10.3)	NA	NA
OCD	4 (20)	0	2 (5.1)	NA	NA
Agoraphobia	2 (10)	1 (9.1)	2 (5.1)	1.80 [0.10 - 31.99]	0.57 [0.05 - 6.97]
ADHD	0	0	2 (5.1)	NA	NA
Anorexia nervosa	3 (15)	2 (18.2)	1 (2.6)	1.19 [0.17 - 8.47]	0.13 [0.01 - 1.54]
Panic disorder	1 (5)	0	1 (2.6)	NA	NA
GAD	2 (10)	0	1 (2.6)	NA	NA
Suicide attempts	4 (20)	6 (54.4)	27 (69.2)	4.50 [0.89 - 22.74]	1.88 [0.48 - 7.36]
Smoking	2 (10)	3 (27.3)	21 (53.8)	3.38 [0.47- 24.29]	3.11 [0.72-13.51]
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>T (67)</i>	<i>T (67)</i>
No. of diagnoses	1.70 (1.22)	2.09 (0.70)	3.46 (1.80)	2.50**	2.62, <i>p</i> = .07 <i>d</i> = 1.0

Note. **p* < .05, ***p* < .01. ADHD= Attention deficit hyperactivity disorder, ODD= Oppositional Deviant Disorder, GAD= Generalized Anxiety Disorder, BPD= Borderline Personality Disorder, OCD= Obsessive Compulsive Disorder, PTSD= Posttraumatic Stress Disorder, NA = not applicable.

8.2.4 Clinical Correlates

Table 13 shows results of one-way ANOVAs and MANOVAs. MANOVAs were performed for group comparisons of internalizing psychopathology (BDI-II, DASS subscales, YSR internal) and symptoms of BPD (QTF, BSL-95). As expected, the NC group showed the lowest scores of psychopathology. The NSSI group had significantly higher symptoms of depression (DASS, BDI) compared with the CC group; there were no significant differences in anxiety symptoms. For the comparison of the QTF and BSL-95 scores, adolescents with BPD were excluded from adolescents with NSSI disorder. Between adolescents with NSSI disorder without BPD (QTF: $Mdn = 3.24$; BSL-95: $Mdn = 173.34$) and adolescents with NSSI disorder and BPD (QTF: $Mdn = 3.54$; BSL-95: $Mdn = 185.06$) there was no significant difference, and effect sizes were small regarding the QTF total score ($U = 59.50$, $p = .39$, $r = 0.17$) and the BSL-95 total score ($U = 37.00$, $p = .84$, $r = 0.05$), but results have to be interpreted with caution as the sample size of adolescents with NSSI and BPD was very small ($n = 8$).

The one-way ANOVAs yielded significant group differences for functional impairment (GAF), general psychopathology (YSR), externalizing symptoms (YSR external), and difficulties in emotion regulation (DERS) between non-clinical and clinical groups as well as between clinical controls and adolescents with NSSI. The differences between the NSSI and NSSI-C groups were statistically not significant but showed a trend toward higher psychopathology of the NSSI group.

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Table 13

*Clinical Correlates of Non-Clinical Adolescents (NC), Clinical Controls (CC), Adolescents with NSSI without Impairment/Distress (NSSI-C), and Adolescents with NSSI Disorder (NSSI), as well as MANOVA and ANOVA with Orthogonal Contrasts and Effect Sizes (Cohen's *d*) Between Non-clinical and Clinical groups (NC vs. Rest), Clinical Controls and NSSI (CC vs. NSSI total), and NSSI vs. NSSI-C*

Questionnaire	NC <i>M (SD)</i>	CC <i>M (SD)</i>	NSSI-C <i>M (SD)</i>	NSSI <i>M (SD)</i>	NC vs. rest	Cohen's <i>d</i>	CC vs. NSSI total	Cohen's <i>d</i>	NSSI disorder vs. NSSI-C	Cohen's <i>d</i>
ANOVA					<i>T</i> (91.52)		<i>T</i> (40.22)		<i>T</i> (38.67)	
GAF	94.20 (3.87)	59.55 (6.40)	56.27 (4.50)	53.70 (10.17)	34.84**	7.26	-2.55*	0.80	1.19	0.38
					<i>T</i> (92)		<i>T</i> (92)		<i>T</i> (92)	
YSR Total ^a	51.60 (14.23)	83.79 (19.13)	98.93 (18.11)	111.31 (26.77)	11.72**	2.44	2.97**	0.62	1.22	0.25
YSR.EXT ^a	8.08 (4.32)	12.91 (1.74)	18.28 (9.38)	21.31 (11.32)	5.89**	1.23	2.17*	0.45	0.48	0.10
DERS	70.59 (16.89)	97.79 (24.14)	108.16 (17.55)	123.42 (25.80)	8.25**	1.72	2.76**	0.58	2.09	0.44
MANOVA 1					<i>F</i> (3, 92)		<i>F</i> (3, 92)		<i>F</i> (3, 92)	
DASS depression ^b	1.25 (1.76)	8.84 (5.73)	11.83 (6.37)	13.82 (4.56)	165.85**	2.88	7.86**	0.81	1.51	0.41
DASS anxiety ^b	1.84 (2.19)	7.63 (4.49)	7.56 (4.71)	8.95 (5.26)	68.08**	1.89	0.11	0.17	0.80	0.28
DASS stress ^b	3.68 (2.74)	8.83 (4.40)	10.60 (4.37)	11.38 (4.60)	71.73**	1.88	2.71	0.54	0.20	0.16
BDI ^b	5.57 (5.87)	23.36 (13.11)	30.22 (9.38)	36.32 (12.32)	155.19**	2.70	11.07**	1.03	3.16	0.74
YSR.INT ^b	8.18 (6.58)	25.28 (9.67)	31.37 (8.29)	33.75 (10.04)	169.24**	2.78	6.47*	0.91	0.51	0.29
MANOVA 2					<i>F</i> (3, 72)		<i>F</i> (3, 72)		<i>F</i> (3, 72)	
QTF ^{ac}	1.44 (0.36)	2.33 (0.90)	2.99 (0.48)	3.21 (0.83)	100.00**	2.42	12.91**	0.94	0.25	0.42
BSL-95 ^{ac}	38.04 (17.47)	120.47 (76.01)	140.80 (64.29)	186.62(64.93)	108.38**	2.45	4.79*	0.75	1.69	0.62

Note. GAF = Global Assessment of Functioning; YSR = Youth Self Report, INT = internal, EXT = external; DASS = Depression Anxiety Stress Scales; BDI = Beck's Depression Inventory; QTF = Questionnaire of Thoughts and Feelings; BSL-95 = Borderline Symptom List; DERS = Difficulties in Emotion Regulation Scale; **p* < .05; ***p* < .01; ****p* < .001. ^alog transformed / ^bsquare root transformed, ^cadolescents with BPD were excluded from these analyses

8.3 Results Main Study 2: Personality in Adolescents with NSSI

8.3.1 Junior Temperament and Character Inventory

As reported in Table 4, significant group differences were shown on the temperament scales novelty seeking, $F(3, 130) = 4.32, p < 0.01, \eta^2 = 0.09$, harm avoidance, $F(3, 130) = 18.80, p < 0.01, \eta^2 = 0.30$, reward dependence, $F(3, 130) = 6.47, p < 0.01, \eta^2 = 0.13$, and persistence $F(3, 130) = 9.57, p < 0.01, \eta^2 = 0.18$, on the character scale self-directedness, $F(3, 130) = 32.71, p < 0.01, \eta^2 = 0.43$, and cooperativeness, $F(3, 130) = 2.99, p = 0.03, \eta^2 = 0.06$. However, there was no significant group difference regarding self-transcendence, $F(3, 130) = 1.28, p = 0.28, \eta^2 = 0.03$.

8.3.2 Barratt Impulsiveness Scale

A MANOVA was performed for group comparisons on impulsivity with the BIS and its subscales. As expected, the group main effect was significant, $F(3, 82) = 9.21, p < 0.01, \eta^2 = 0.25$, with BPD reporting the highest impulsivity. There was no significant group x impulsivity interaction, $F(6, 164) = 1.36, p = 0.23, \eta^2 = 0.05$. As shown in Table 4, the subsequent one-way ANOVA yielded significant group differences regarding impulsivity for the total scale, $F(3, 130) = 9.21, p < .01, \eta^2 = 0.25$, as well as for the subscales attentional, $F(3, 130) = 7.47, p < 0.01, \eta^2 = 0.21$, and nonplanning impulsivity, $F(3, 130) = 8.32, p < 0.01, \eta^2 = 0.23$, but not for the subscale motor impulsivity $F(3, 130) = 2.13, p = 0.10, \eta^2 = 0.07$. Planned comparisons indicated significant differences between NC and clinical groups for the total scale and subscales attentional and nonplanning impulsivity. CC is significantly less impulsive than the NSSI groups on every subscale. NSSI differs from NSSI+BPD regarding nonplanning impulsivity, but not regarding attentional impulsivity.

8.3.3 Go/No Go-Task

Performance in the non-emotional task

Separate one-way ANOVAs were conducted for every outcome of the Go/No Go task. As shown in Table 14, there was no significant group effect for participant's sensitivity index, $F(3, 151) =$

0.93, $p = 0.43$, for commission errors, $F(3, 151) = 0.43$, $p = 0.73$, and no group effect on omission errors, $F(3, 154) = 1.22$, $p = 0.31$, and reaction time, $F(3, 147) = 2.06$, $p = 0.11$.

Performance in the emotional task when emotional faces were Go trials and neutral faces were No Go trials

Sensitivity Index d' . The 4 (Group) x 2 (Facial Emotion) ANOVA of participant's sensitivity index indicated no significant interaction, $F(3, 148) = 1.22$, $p = 0.30$, no significant facial emotion effect, $F(1, 148) = 0.26$, $p = 0.61$, and no significant group effect, $F(3, 148) = 2.3$, $p = 0.08$.

Commission error rate (No Go). The 4 (Group) x 2 (Facial Emotion) ANOVA indicated no significant interaction, $F(3, 148) = 0.43$, $p = 0.73$, and no significant group effect, $F(3, 148) = 1.32$, $p = 0.27$. There was a significant main effect of facial emotion, $F(1, 148) = 29.83$, $p < 0.01$, indicating a higher commission error rate for angry faces than for happy faces.

Omission error rate (Go). The 4 (Group) x 2 (Facial Emotion) ANOVA indicated no significant interaction, $F(3, 155) = 1.53$, $p = 0.21$, and no significant group effect, $F(3, 155) = 1.56$, $p = 0.20$. The main effect facial emotion reached significance, $F(1, 155) = 65.50$, $p < 0.01$, indicating a higher omission error rate for angry faces than for happy faces.

Reaction time (Go). The 4 (Group) x 2 (Facial Emotion) revealed no significant interaction, $F(3, 154) = 0.03$, $p = 1.00$, and no significant group effect, $F(3, 154) = 0.19$, $p = 0.90$. The main effect facial emotion was significant, $F(1, 154) = 20.95$, $p < 0.01$, indicating a faster reaction to happy compared to angry faces.

Performance in the emotional task when neutral faces were Go trials and emotional faces were No Go trials

Sensitivity Index d' . The 4 (Group) x 2 (Face Emotion) ANOVA of participant's sensitivity index indicated no significant interaction, $F(3, 150) = 0.29$, $p = 0.83$, no significant Face Emotion effect, $F(1, 150) = 0.03$, $p = 0.87$, and no significant group effect, $F(3, 150) = 1.84$, $p = 0.14$.

Commission error rate (No Go). The 4 (Group) x 2 (Face Emotion) ANOVA of participant's commission errors revealed no significant interaction, $F(3, 154) = 0.28$, $p = 0.84$,

and no significant main effect (Face Emotion, $F(1, 154) = 0.02, p = .88$; Group, $F(3, 148) = 0.59, p = 0.62$).

Omission error rate (Go). The 4 (Group) x 2 (Face Emotion) ANOVA revealed no significant interaction, $F(3, 152) = 0.34, p = .80$, no significant main effect of Face Emotion $F(1, 152) = 2.51, p = 0.12$, and no significant, but a trend of a group effect, $F(3, 152) = 2.56, p = 0.06$.

Table 14

Sensitivity Index d' , Commission and Omission Errors of the Go/No Go, as well as Reaction Times for Go Trials of Non-Clinical Adolescents (NC), Clinical Controls without NSSI (CC), Adolescents with NSSI Disorder (NSSI), and Adolescents with NSSI and Borderline Personality Disorder (NSSI+BPD).

Condition		NC	CC	NSSI	NSSI+BPD
		<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
<i>d'</i>	X	0.16 (1.16)	0.31 (1.07)	-0.01 (1.30)	-0.27 (1.29)
	Angry Go (Neutral No Go)	0.12 (1.66)	-0.18 (1.59)	0.02 (1.38)	-0.72 (1.46)
	Happy Go (Neutral No Go)	-0.04 (1.47)	0.42 (0.87)	0.08 (1.37)	-0.86 (1.50)
	Neutral Go (Angry No Go)	0.05 (1.12)	0.19 (1.19)	-0.10 (1.33)	-0.40 (1.50)
	Neutral Go (Happy No Go)	0.34 (1.44)	0.36 (0.82)	0.06 (1.46)	-0.62 (1.20)
Commission	X	1.95 (4.55)	2.00 (5.19)	2.02 (4.57)	3.57 (7.45)
	Angry Go (Neutral No Go)	15.42 (14.80)	15.42 (11.22)	18.63 (16.92)	21.15 (16.44)
	Happy Go (Neutral No Go)	8.67 (11.43)	6.67 (10.24)	8.82 (11.80)	13.39 (11.46)
	Neutral Go (Angry No Go)	5.83 (9.34)	4.03 (9.89)	6.37 (9.37)	4.46 (9.31)
	Neutral Go (Happy No Go)	5.42 (10.88)	3.23 (6.43)	5.19 (9.31)	6.25 (9.49)
Omission	X	14.34 (13.24)	12.26 (13.09)	17.21 (15.13)	18.57 (10.46)
	Angry Go (Neutral No Go)	7.38 (12.37)	10.48 (12.95)	6.37 (6.76)	11.61 (10.36)
	Happy Go (Neutral No Go)	0.82 (3.12)	0.00 (0.00)	0.47 (2.40)	1.79 (4.54)
	Neutral Go (Angry No Go)	2.29 (6.71)	2.92 (5.38)	3.54 (9.61)	8.65 (9.39)
	Neutral Go (Happy No Go)	4.30 (16.44)	6.05 (18.78)	6.60 (18.61)	12.50 (18.99)
RT Go	X	373.62 (42.10)	378.22 (41.96)	361.03 (40.66)	353.66 (29.87)
	Angry Go (Neutral No Go)	514.52 (86.87)	529.93 (109.17)	509.37 (83.11)	421.31 (119.90)
	Happy Go (Neutral No Go)	483.46 (72.24)	492.22 (81.30)	478.21 (78.84)	487.61 (96.52)
	Neutral Go (Angry No Go)	503.67 (86.93)	522.27 (89.08)	516.01 (82.00)	517.93 (100.72)
	Neutral Go (Happy No Go)	533.06 (87.16)	546.78 (106.83)	527.60 (95.38)	551.99 (89.60)

Note. d' = sensitivity index; Commission = Commission error; Omission = Omission error, RT Go = reaction time for the go condition. There were no significant group effects.

Reaction time (Go). The 4 (Group) x 2 (Face Emotion) ANOVA of participant's reaction time to Go Stimuli indicated no significant interaction, $F(3, 146) = 0.37, p = 0.77$, and no significant group effect, $F(3, 146) = 0.30, p = 0.82$. The main effect Face Emotion was significant, $F(1, 146) = 11.94, p < 0.01$, indicating a faster reaction to neutral faces, when happy faces serve as No Go compared to angry faces.

8.4 Results Main Study 3: Emotion Recognition in Adolescents with NSSI

8.4.1 Manipulation Check of Mood Induction

To ensure effectiveness of the mood induction, we conducted a Group (NSSI, CC, NC) \times Time (before, after mood induction) repeated-measures ANOVA on self-reported mood (sadness, happiness) for both film clips. As expected, this analysis yielded a significant main effect of time for the sad film clip, $F(1, 121) = 26.00, p < 0.01$. All participants endorsed more sadness after watching the *My Girl* film clip ($M = 3.68, SD = 1.82$) than before ($M = 2.19, SD = 1.68$), $d = 0.85$. There was no main effect of group, $F(2, 121) = 1.46, p = 0.23$, and no Group \times Time interaction, $F(2, 121) = 1.90, p = 0.15$. For the neutral film clip, the analysis yielded, a nonsignificant main effect of group, $F(2, 121) = 0.88, p = 0.42$, and no Group \times Time interaction, $F(2, 121) = 0.26, p = 0.77$. However, the main effect of time was significant $F(1, 121) = 5.45, p = 0.02$, indicating a decrease in emotion intensity for sadness and happiness.

8.4.2 Facial Emotion Recognition

The mean percentage of stages until the first correct response for each of the target emotions and for the three groups after sad and neutral mood induction are displayed in Table 15. For the recognition threshold of the facial expression, we conducted a 3 (Group: NSSI, CC, NC) \times 2 (Mood: neutral, sad) \times 6 (Emotion: happiness, sadness, anger, disgust, fear, neutral) repeated-measures ANOVA. Results yielded a nonsignificant three-way interaction, $F(8.35, 492.661) = 1.49, p = 1.52, \eta_p^2 = 0.02$. Neither the main effect of group, $F(2, 118) = 1.04, p = 0.35, \eta_p^2 = 0.01$, nor the main effect of mood, $F(1, 118) = 0.99, p = 0.32, \eta_p^2 = 0.01$, was statistically significant. The main effect of emotion was clearly significant, $F(2.59, 305.85) = 64.77, p < 0.01, \eta_p^2 = 0.35$. In particular, happiness was identified significantly earlier than the other emotions in all groups,

$F(1, 118) = 486.41, p < 0.01, \eta_p^2 = 0.81$, and sadness was identified significantly later than the other emotions in all groups, $F(1, 118) = 193.81, p < 0.01, \eta_p^2 = 0.62$.

To examine whether emotion recognition in the NSSI group was associated with differences in the use of psychotropic medication, a *t*-test was conducted. Therefore, the mean percentage of stages until the first correct response was examined as a function of medication usage. Across emotion categories, there was a significant difference between adolescents with NSSI with psychotropic medications ($n = 26, M = 79.77, SD = 7.99$) and without medications ($n = 18, M = 73.68, SD = 8.15$), $t(42) = -2.47, p = 0.02, d = 0.75$, indicating that adolescents without psychotropic medication correctly identified facial expressions earlier than medicated adolescents NSSI. These two groups did not significantly differ on the YSR total score, $t(38) = -0.82, p = 0.42$.

Table 15

Mean Percentage (Standard Deviation) of Stages until the First Correct Recognition/Response after Sad and Neutral Mood Induction for Adolescents with NSSI (NSSI), Clinical Controls (CC), and Non-Clinical Controls (NC), as well as Post Hoc Comparisons for Emotions.

Emotion	Neutral mood			Sad mood			Contrast Goal vs other emotions
	NSSI	CC	NC	NSSI	CC	NC	<i>F</i> (1, 118)
Anger	63.00 (16.71)	60.56 (12.19)	63.61 (13.31)	66.25 (12.82)	65.1 (15.9)	61.47 (11.9)	14.70**
Fear	65.06 (16.69)	65.33 (15.88)	62.17 (19.97)	67.07 (18.84)	67.47 (15.12)	62.85 (17.55)	19.47**
Disgust	64.90 (15.32)	60.15 (12.39)	60.26 (16.87)	59.92 (15.88)	62.98 (15.75)	59.24 (15.62)	0.42
Sadness	71.12 (12.3)	65.98 (13.52)	68.24 (13.31)	73.21 (12.48)	68.41 (16.9)	68.03 (11.90)	193.81**
Neutral	64.93 (25.63)	58.59 (19.64)	56.05 (24.00)	62.45 (25.28)	60.43 (20.21)	59.45 (22.85)	0.11
Happiness	47.57 (14.59)	42.10 (9.31)	46.81 (15.72)	47.33 (13.39)	46.10 (17.41)	45.00 (14.66)	486.41**

Note. There were no significant group differences. ** $p < .01$

8.4.3 Accuracy of Emotion Recognition

The percentages of correctly recognized emotional facial expressions after sad and neutral mood induction in the three groups are presented in Table 16. For the accuracy of emotion recognition,

the 3 (Group: NSSI, CC, NC) \times 2 (Mood: neutral, sad) \times 6 (Emotion: happiness, sadness, anger, disgust, fear, neutral) repeated-measures ANOVA yielded a nonsignificant three-way interaction $F(8.67, 511.45) = 0.39, p = 0.93, \eta_p^2 = 0.007$. Neither the main effect of group, $F(2, 118) = 0.65, p = 0.52, \eta_p^2 = 0.01$, nor of mood, $F(1,118) = .015, p = 0.69, \eta_p^2 = 0.001$ was statistically significant. Across all the emotions, the fewest errors were made for recognizing happy facial emotions, $F(1, 118) = 743.93, p < 0.01, \eta_p^2 = 0.86$. The most errors were made identifying neutral facial expressions, $F(1, 118) = 74.24, p < 0.01, \eta_p^2 = 0.38$ followed by fearful facial expressions, $F(1, 118) = 24.88, p < 0.01, \eta_p^2 = 0.17$.

Table 16

Mean Percentage (Standard Deviation) of Correctly Recognized Emotional Facial Expressions after Sad and Neutral Mood Induction for Adolescents with NSSI (NSSI), Clinical Controls (CC), and Non-Clinical Controls (NC)

Emotion	Neutral			Sad			Goal vs. target emotion F (1, 118)
	NSSI	CC	NC	NSSI	CC	NC	
Anger	89.01 (18.06)	84.69 (15.02)	88.92 (12.46)	88.63 (13.97)	89.28 (10.73)	89.21 (11.11)	136.95**
Fear	69.39 (20.96)	68.36 (22.11)	63.55 (27.20)	73.24 (22.75)	68.87 (19.84)	65.59 (23.13)	24.89**
Disgust	74.49 (22.87)	72.95 (25.29)	67.34 (25.42)	72.59 (24.38)	73.46 (22.57)	65.88 (22.74)	10.58**
Sadness	77.46 (22.27)	77.04 (19.57)	78.42 (20.43)	75.86 (20.65)	73.97 (20.59)	76.67 (19.05)	0.01
Neutral	53.65 (27.49)	60.20 (29.20)	55.97 (31.65)	56.09 (31.87)	57.14 (28.83)	55.39 (32.16)	74.24**
Happiness	98.05 (4.95)	96.42 (6.30)	97.08 (6.50)	98.70 (4.15)	98.97 (3.74)	99.70 (2.04)	743.93**

Note. There were no significant group differences. Multiple comparison procedures (Bonferroni) were conducted at $p < 0.05$. * $p < .01$.

Incorrect responses of neutral and fearful facial expressions are presented in Table 17. Neutral facial expressions were significantly more often identified as fearful expressions, $F(1, 118) = 164.55, p < 0.01$, and fearful expressions were significantly more often identified as disgusted expressions, $F(1, 118) = 94.49, p < 0.01$.

Table 17

Mean (Standard Deviation) of Misinterpretations of Neutral and Fearful Facial Expressions as other Emotions for Adolescents with NSSI (NSSI), Clinical Controls (CC), and Non-Clinical Controls (NC)

Emotion	Neutral facial expressions			Fearful facial expressions			Target vs goal emotions
	NSSI	CC	NC	NSSI	CC	NC	F (1, 118)
Anger	0.11 (0.49)	0.04 (0.19)	0.18 (0.39)	0.14 (0.34)	0.14 (0.44)	0.29 (0.81)	136.95**
Fear	4.61 (3.38)	4.14 (2.94)	4.31 (3.50)				24.89**
Disgust	0.36 (0.61)	0.54 (1.37)	0.53 (1.00)	2.02 (2.05)	2.64 (1.98)	3.00 (2.71)	10.60**
Sadness	0.55 (0.76)	0.50 (0.69)	0.65 (0.97)	1.00 (0.94)	.96 (.99)	1.18 (1.20)	0.01
Neutral				0.48 (0.92)	0.61 (1.22)	0.33 (0.55)	74.24**
Happiness	0.09 (0.29)	0.29 (0.60)	0.24 (0.56)	0.11 (0.32)	0.04 (0.19)	0.16 (0.55)	743.93**

Note. There were no significant group differences. Multiple comparison procedures (Bonferroni) were conducted at $p < 0.05$. * $p < .01$.

8.4.4 Ratings of Stimulus Valence and Arousal

Group means and standard deviations of valence and arousal ratings for the correctly recognized stimuli are presented in Table 18. Valence and arousal ratings indicated that the stimuli elicited different emotional responses in the three groups. The main effect of group was significant for arousal, $F(2, 123) = 5.64, p < 0.01, \eta_p^2 = 0.08$, and valence, $F(2, 123) = 5.1, p < 0.01, \eta_p^2 = 0.07$. All groups rated the valence of happy facial expressions as significantly more pleasant compared to the other emotions, $M = 3.85 (SD = 0.14), p < 0.01$, and anger as most unpleasant, $M = 5.41 (SD = 0.14), p < 0.01$. In addition, there was a significant main effect of emotion for arousal, $F(2.85, 347.50) = 9.1, p < 0.01, \eta_p^2 = 0.07$, and for valence, $F(3.16, 389.21) = 50.84, p < 0.01, \eta_p^2 = 0.29$. Post hoc Bonferroni-corrected contrasts indicated a significant difference, in that adolescents with NSSI rated the stimuli as more unpleasant ($p = 0.01$) and arousing ($p < 0.01$) than nonclinical adolescents. The contrasts between adolescents with NSSI and the clinical control group were not significant for arousal ($p = 1.00$) or valence ($p = 1.00$). The contrasts between clinical controls and nonclinical controls were borderline significant for arousal ($p =$

0.06) and valence ($p = 0.059$). Valence and arousal were assessed after both film clips; however, similar to the results for emotion recognition, mood had no significant effect on arousal, $F(1, 123) = 0.53, p = 0.46, \eta_p^2 = 0.004$, or on valence, $F(1, 123) = 1.02, p = 0.31, \eta_p^2 = 0.17$.

Including psychopathology assessed with the YSR total score as a covariate in the analyses, the main effect of group was significant for arousal, $F(2, 99) = 5.40, p = 0.01, \eta_p^2 = 0.1$, but only borderline significant for valence, $F(2, 99) = 2.61, p = 0.08, \eta_p^2 = 0.05$. There was a significant main effect of emotion for valence, $F(3.27, 323.65) = 4.53, p < 0.01, \eta_p^2 = 0.04$, but no significant main effect of emotion for arousal, $F(3.16, 312.66) = 0.66, p = 0.59, \eta_p^2 = 0.19$.

Table 18

Mean (Standard Deviation) Valence and Arousal Ratings for Adolescents with NSSI (NSSI), Clinical Controls (CC), and Non-Clinical Controls (NC) and group comparisons (C)

Emotion	Arousal				Valence			
	NSSI (1)	CC (2)	NC (3)	C	NSSI (1)	CC (2)	NC (3)	C
Anger	5.95** (0.27)	6.13 (0.34)	7.14** (0.27)	1 < 3	5.64 (0.22)	5.70 (0.28)	5.03 (0.21)	
Fear	6.26 (0.28)	6.08 (0.35)	7.11 (0.27)		5.22 (0.23)	5.46 (0.29)	4.81 (0.22)	
Disgust	6.06 (0.28)	6.38 (0.36)	6.93 (0.27)		5.32 (0.23)	5.47 (0.29)	4.63 (0.22)	
Sadness	6.18** (0.25)	6.37 (0.32)	7.35** (0.24)	1 < 3	5.44 (0.23)	5.81 (0.29)	5.05 (0.22)	
Neutral	6.33 (0.31)	6.17 (0.40)	7.33 (0.30)		4.94* (0.23)	4.46 (0.29)	3.99* (0.22)	1 > 3
Happiness	6.52** (0.24)	7.12 (0.30)	7.83** (0.23)	1 < 3	4.66** (0.22)	3.97 (0.28)	3.00** (0.21)	1 > 3

Note. * $p < 0.05$, ** $p < 0.01$, indicating significant group differences. Multiple comparison procedure (Bonferroni) was conducted at $p < 0.05$. Valence: 1 = very pleasant, 9 = very unpleasant; Arousal: 1 = very excited, 9 = very calm

9. General Discussion

9.1 Summary of the Main Results

The aim of this thesis was to examine emotion regulation in female adolescents with NSSI disorder (NSSI). Therefore we investigated self-reported emotion regulation, the suggested diagnostic criteria, clinical and psychological correlates of NSSI, personality traits specific to patients with NSSI, and how adolescents with NSSI perceive facial expressions.

Our results showed that adolescents with NSSI disorder not only reported significantly more emotion regulation difficulties than adolescent without mental disorder (NC), but also than adolescents with other mental disorders (CC). This result is in line with previous studies on emotion regulation in individuals with NSSI behaviour (Bresin, 2014; Muehlenkamp, Kerr, et al., 2010; Muehlenkamp, Peat, et al., 2012). It provides supporting evidence for the affect regulation function of NSSI. Almost all adolescents with NSSI (97.4%) reported psychological precipitants like sadness, tension, anger, distress and self-criticism. Furthermore, the most often reported consequences of NSSI were a relief of negative feelings and to feel better. NSSI seems to be an effective emotion regulation strategy, this is in line with previous research (Armey et al., 2011; for a review see Klonsky, 2007). The most frequently reported functions were positive and negative automatic reinforcement, in line with Zetterqvist, et al. (2013), positive and negative social reinforcement were less often reported. We conclude that the goal of a self-injurious act often is emotion regulation. Our findings support not only Chapman, Gratz and Brown's (2006) experiential avoidance model, which suggests that individuals engage in NSSI in order to avoid unwanted emotional states, but also the automatic negative reinforcement function of NSSI in the Nock and Prinstein (2004) model.

Emotion dysregulation is a transdiagnostic factor (Aldao & Nolen-Hoeksema, 2010; Kring & Sloan, 2010). Therefore it is not surprising that adolescents with NSSI not only report more externalising and internalizing symptoms, they also fulfil more psychological disorders than CC. Major Depression was the most often diagnosed psychiatric disorder, with more than 80% of the adolescents with NSSI suffering from it.

Regarding predisposing factors for emotion dysregulation, personality traits are of special interest. In BPD, a pattern of high harm avoidance paired with high harm avoidance was found

(Barnow et al., 2005; Cloninger & Svrakic, 1997; Ha et al., 2004; Joyce et al., 2003; Pukrop, 2002; Kaess et al., 2013). The approach avoidance conflict generated from this pattern might be a reason for the emotional instability patients with BPD experience (Cloninger, 1994). We replicated this pattern in adolescents with NSSI compared to NC and CC. It is notable that adolescents with NSSI+BPD scored even higher on novelty seeking and harm avoidance. Altogether, adolescents with NSSI indicated significantly more impairment in personality functioning on the subscales of the JTCI than CC, but less than the NSSI+BPD group. These results indicate that adolescents with NSSI+BPD and adolescents with NSSI without BPD show the same personality pattern, but in adolescents with NSSI and BPD, this pattern is even more pronounced and therefore they are even more impaired in personality functioning than adolescents with NSSI without BPD. Nevertheless, longitudinal studies are needed to investigate if adolescents with NSSI without BPD develop additional BPD symptoms over time.

As previously explained, almost all adolescents with NSSI endorsed negative emotions prior to the self-injurious act. To find the trigger of these negative emotions could help the adolescents to deal with this emotions in an adaptive way. Misperceptions in social interactions may lead to an increase in emotional arousal and a worsening of mood state, as they were shown to be potent triggers for emotional arousal, and affective instability in BPD (Ebner-Primer et al., 2007). However, the results of the emotion recognition task indicated that adolescents with NSSI have no general deficit in accurately recognizing emotional facial expressions. There were no group differences in emotion intensity required to correctly identify happy, sad, angry, disgusted, fearful, or neutral facial expressions. In addition, there were also no group differences with regard to the accuracy of emotion recognition. For neutral facial expressions no bias effect was found. Our results might indicate that adolescents with NSSI in general possess basic social skills, such as facial emotion recognition. However, the question remains if these skills can be used in stressful situations and in situations with specific triggers. Even though the sad mood induction used in our sample had a large effect on mood, it did not seem to influence emotion recognition. Therefore, further research on emotion recognition in difficult social interactions or in different mood states (under stress or in anger) is of interest. Regarding valence and arousal ratings, adolescents with NSSI rated neutral and happy facial expressions as more unpleasant and angry, sad and happy facial expressions as more arousing than the NC group. These results indicate that although adolescents with NSSI adequately recognize the emotion happiness, they

interpret the positive emotional expression as more unpleasant and arousing. The information processing of positive emotions and its role in emotion regulation should be investigated in future studies, especially regarding the specificity to NSSI disorder, as we found no significant difference between adolescents with NSSI and the clinical controls, and previous studies did not include a clinical control group.

It further is of interest, why adolescents with NSSI choose to injure themselves and enjoy the immediate benefits of NSSI (e.g., emotion regulation) with less concern for the long-term consequences of NSSI (e.g., scars, shame). Impulsiveness might drive individuals to act rashly in the context of negative emotions because long-term benefits become less important than short-term gains of emotion regulation (e.g., The Theory of Urgency, Cyders & Smith, 2008; also see Tice et al., 2001). We found higher impulsivity scores on all subscales of the Barratt Impulsiveness Scale (attentional, non-planning, and motor impulsivity) among adolescents with NSSI compared to CC. However, this difference was not observed in their performance in the Go/No Go task, as neither a group, nor a facial emotion effect could be found. The different results found using self-reported and experimentally assessed impulsivity may be explained by the measurement of different impulsivity constructs. While self-report questionnaires measure general response tendencies (traits), behavioural tasks may rather measure spontaneous reactions that are influenced by current cognitive processes (Mc Closkey et al., 2012). Future experiments in adolescents with NSSI should include mood manipulations prior to assessing behavioural measures of impulsivity, as adolescents with NSSI might only react impulsive in the context of negative emotions.

In conclusion, adolescents with NSSI endorse much more emotion regulation difficulties than other adolescents with or without psychiatric disorders. NSSI seems to be able to help them deal with these emotion regulation difficulties. Furthermore, with the currently proposed *DSM-5* criteria for NSSI disorder, a sample of adolescents could be identified who were more impaired than adolescents who were also hospitalized due to mental disorders but did not engage in NSSI. In addition, 80% of adolescents with NSSI disorder did not meet criteria for BPD, supporting the evidence for a distinct diagnostic entity. On the criteria level, adolescents with NSSI disorder without a comorbid BPD endorsed on average 2.3 borderline symptoms compared with a mean of 0.3 symptoms endorsed by clinical control adolescents (CC). The relatively low level of adolescents with NSSI fulfilling BPD criteria is not surprising in the light of the study by Glenn

and Klonsky (2011) which found that the overlap between BPD and NSSI appears to be no more significant than that observed in other major psychiatric disorder, thus concluding that NSSI occurs independently of BPD. Furthermore, BPD diagnostic status cannot predict persistence in NSSI (Yen et al., 2015), giving supporting evidence for the distinction between these disorders. Results from the JTCI (Goth & Schmeck, 2009), measuring personality on a dimensional scale, further support the distinction between NSSI and BPD.

Regarding the proposed diagnostic criteria for DSM-5 (APA, 2013), criterion C might need some revision. As in the Zetterqvist et al. (2013) study, our sample contained some patients who fulfilled NSSI criteria A, B, D, and E, but negated that the behaviour caused them any impairment or distress. Currently, there is an on-going discussion on whether the impairment/distress criterion should be part of each diagnosis (Rapee, Bögels, van der Sluis, Craske, & Ollendick, 2012), also with regard to the difficulty to operationalize impairment and distress in a coherent and objective manner (Plener, Fegert, & Freyberger, 2012). Especially for patients with NSSI, this might be a difficult question. These patients may see NSSI as a (temporary) solution to reduce distress (Wilkinson & Goodyer, 2011; Zetterqvist, et al., 2013). Consequently, they do not report impairment or distress. For therapy, the missing distress and impairment is of special importance. Patients with NSSI will not easily agree to give up self-injury as their solution to reduce distress.

9.1.1 General Limitations and Strengths

Several limitations of this study should be noted. First, our sample consisted of female adolescents admitted to a psychiatric unit and thus may not generalize to other samples. For example, females have been shown to perform better in recognition tasks than males (McClure, 2000). Traditionally, NSSI was seen as a “female” problem. However, a new meta-analysis shows that prevalence rates of NSSI behaviour are not significantly higher among females than among men (Swannell et al., 2014). Therefore, male adolescents with NSSI should be included in further studies. Second, the design of the study was cross-sectional. The current study cannot explain whether certain personality traits favour the development of NSSI or if NSSI leads to a certain personality expression. This has to be investigated in future prospective longitudinal studies. Third, our subsample sizes were small, so the power was limited for some analyses. The relatively small number of clinical adolescents without NSSI can be explained by the high

prevalence rates of NSSI (30-61%) in inpatient samples (Kaess et al., 2013; Nock & Prinstein, 2004). Fourth, NSSI is a disorder in Section 3 of the *DSM-5* (APA, 2013), but the proposed criteria are not finalized. Future research might show that adaptations of these criteria are necessary. Fifth, it will be important to describe the influence of comorbid disorders, as the clinical control group was very heterogeneous. Finally, replication of our findings is needed to specify and support our hypothesis.

Strengths of the study were the use of the proposed *DSM-5* diagnostic criteria for NSSI, tackling the problems of previous research on self-injury, where different definitions were used and investigating samples with repetitive and single episodes of NSSI, and the use of a multi-method assessment, employing self-report measures, structured clinical interviews and experimental tasks. The inclusion of a clinical control group suffering from another psychopathology than NSSI, allowed us to conclude to what extent our findings are unique to adolescents with NSSI.

9.1.2 Clinical and Research Implications

Our results provided supporting evidence for an emotion dysregulation in adolescents with NSSI. As the effectiveness and appropriateness of a specific emotion regulation strategy can only be evaluated in the context with regard to the goal of the emotion regulation process (Gratz & Roemer, 2004), future studies should try to examine emotion regulation in specific situations and evaluate the adaptiveness and the successfulness of the strategies used. However, as sometimes immediate losses go hand in hand with long-time gains; it is difficult to design a study like this. As negative emotions often arise from interpersonal difficulties, a first step might be a qualitative research about emotion regulation strategies used in real life after arguments with questions regarding the outcome (e.g. solution of the situation, personal satisfaction with the solution). In a second survey somewhat later, long term outcomes could be assessed. Ecological momentary assessment (EMA) provides an opportunity to assess emotion regulation in a variability of settings. As suggested by Aldao (2013), it will be informative to experimentally induce the implementation of regulation strategies via EMA. If this implementation is successful, it might be the first step to the development of an emotion regulation app, which could be introduced in an NSSI specific treatment and support an individual in choosing an appropriate emotion regulation strategy.

So far, there is a lack of specific treatment programs for adolescents with NSSI. As we found adolescents with NSSI to be significantly less impaired in personality functioning and to experience less internalizing and externalizing symptomatology than adolescents with BPD, they might need a lower intensity of treatment sessions than the common treatments for BPD (e.g., Dialectical Behavioural Therapy). Therefore, the development of specific treatment programs may not only optimize treatment, but also reduce treatment costs. A recent review (Turner, Austin, & Chapman, 2014) on psychological and pharmacological interventions for NSSI behaviour showed promising results for dialectical behavioural therapy, for emotion regulation therapy, cognitive therapy, and psychodynamic therapy. However, controlled efficacy studies are rare, none of this studies included adolescents with NSSI disorder and there are currently no independently replicated efficacious interventions available (Ougrin, Tranah, Leigh, Taylor, & Asamow, 2012).

So far, only a minority of adolescents with NSSI receives treatment in any form (Brunner et al., 2014). Most of the adolescents who self-harm do not seek help for this behaviour (Rowe et al., 2014). Of those who seek help, the majority turned to friends and family for support. Barriers to help-seeking included fear of negative reactions from others including stigmatisation, fear of confidentiality being breached and fear of being seen as ‘attention-seeking’ (Fortune et al., 2008). According to Brunner et al. (2014), to date, no intervention has been shown to increase help-seeking behaviour in young people who self-harm. As individuals with NSSI also show high suicidality, it will be important to offer them appropriate treatment options and to lower the barriers for help seeking. Low-threshold services like an internet page or an app might be helpful for first aid in emotional crisis. In a quick research in google play on the 05th of april 2015, I found multiple apps for suicide prevention, but none for the prevention of NSSI.

Our results provide several leads, which intervention in psychotherapy might be most promising. Considering that adolescents with NSSI see self-injury as a solution to regulate distress, self-injury should rather be reflected and questioned with the patient than be forbidden. The elaboration of alternative strategies to reduce negative affect seems promising in order to motivate the patient to change his/her behaviour. I further suggest the inclusion of positive emotions in emotion regulation trainings, because adolescents with NSSI seem to evaluate happiness in others differently. Von Ceumern-Lindenstjerna et al. (2007) suggested sensitizing patients to the perception of positive stimuli and the experience of positive emotions. A patient

of mine was especially anxious to hurt herself at her families Christmas dinner. Although she knows that she is loved and appreciated by her family, the experience of positive emotions around her frightens her and she is afraid to have to cry or injure herself.

If replicated, our finding that adolescents with NSSI have no deficits in emotion recognition could mean that in treatment, a focus on emotion recognition is not strictly necessary. Furthermore, although adolescents with NSSI do not have difficulties recognizing facial emotions in others, we do not yet know how well they recognize their own emotions or how they react to emotional facial expressions. The correct identification of one's own emotions might be a crucial step in emotion regulation. Our results indicate that the difficulties adolescents with NSSI endorse in social relationships are not likely to be the result of an inability to identify others' emotional states. Therefore, further research on interpersonal difficulties leading to NSSI is warranted. Emotion recognition trainings as well as the use of Go/No Go task to train to inhibit responses do not seem promising in the light of our results.

However, the finding that adolescents with NSSI reported heightened levels of impulsivity might be of special importance. Impulsivity might explain the difficulties patients with NSSI have to resist the urge to injure themselves (Glenn & Klonsky, 2010), and could be particularly responsible for the high suicidality in patients with NSSI (Klonsky et al., 2013), as impulsivity is a common risk factor for suicidal behaviour (Gvion & Apter, 2011). Therefore, strategies to deal with impulsivity should be part of a comprehensive treatment program of NSSI.

Regarding the potentially harmful personality traits in adolescents with NSSI, the development of treatment programs specific to the individual's personality difficulties should at least be considered. Given the idea that particular personality traits can cause impairments in personality functioning, it is surprising that so far no psychological programs promoting character development in accordance to Cloninger's personality model (1987) exist. Adolescents with potentially impairing character traits might profit from such specific interventions with additive designs, tailored to individual personality deficits.

In conclusion, our results of NSSI as a highly impairing disorder, associated with high psychopathology combined with the clear differentiation from adolescents with BPD, support the validity of NSSI criteria and the need for specific treatment programs.

9.2 Pre-Study: Emotion Regulation in Social Anxiety

The aim of the pre-study was to investigate if the facial morphing task is feasible and sensitive to detect group differences. Furthermore, we wanted to investigate whether social anxiety is related to emotional mimicry, emotion recognition, and self-reported emotion regulation difficulties. The results indicate that HSA individuals show subtle differences in emotional mimicry compared to LSA individuals. In addition, a tendency toward poorer emotion recognition ability characterized HSA participants, who endorsed more self-reported emotion regulation difficulties across different emotion regulation domains.

9.2.1 Facial Mimicry in Socially Anxious Individuals

To our knowledge, this is the first study examining emotional mimicry with an experimental paradigm in individuals with social anxiety. So far this topic has been investigated only in public speaking anxiety (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004). Importantly, we replicated the general emotional mimicry effect for each tested emotion and not only for the well-evaluated emotions happiness and anger, with their corresponding muscles *m. zygomaticus major* and *m. corrugator supercilii* (Hess & Fischer, 2013). In addition, we confirmed the emotional mimicry effect also for the less often investigated emotions anxiety (Moody et al., 2007) and sadness (Cram & Criswel, 2010), both indexed by *m. frontalis medialis* activity, as well as for disgust with *m. levator labii* activity (Lundqvist & Dimberg, 1995). The emotional mimicry effect was indicated by either a significant interaction effect (EMG activity for the target emotion increased, whereas there was no change for the neutral emotion) or a significant main effect of emotion, with a higher activity for the target emotion than for the neutral emotion. The successful replication and extension of emotional mimicry effects confirm the validity of the novel set of dynamic colour stimuli and support the utility of dynamic images because of their power to elicit particularly large mimicry effects (Sato et al., 2008). The emotional mimicry effect for each emotion was generally shown in both groups, providing the basis for successful social interactions by fostering affiliation and liking (Lakin et al., 2003). Nevertheless, even small differences in emotional mimicry could lead to difficulties in social interactions. Therefore, examining group comparisons in detail is of special interest. HSA participants reacted to disgusted and neutral faces with higher *m. levator labii* activation. This is comparable with the results from Vrana and Gross (2004) indicating more *m.*

corrugator supercilii activity as a reaction to neutral faces in people high in fear of public speaking. Both reactions can be interpreted as negative emotional facial expressions. The stronger mimicry reaction to disgust is of special importance. The more beneficial influence of positive emotional mimicry on social interactions compared to the mimicry of negative emotions has already been highlighted (Hess et al., 2000; Knutson, 1996). Furthermore, Anthropologists have suggested that disgust discourages moral transgressions and helps maintain collective boundaries (e.g., Douglas, 1966). This idea is supported by experimental findings of a relation between disgust and negative moral evaluations (Inbar, Pizarro, Knobe, & Bloom, 2009; Wheatley & Haidt, 2005). Disgust is thought to be an adaptive food rejection response that protected humans against ingestion of toxic foods and contact with contaminating substances (Marzillier & Davey, 2004). It seems to have evolved into a more complex social-moral disgust elicited by a wider range of stimuli that vary across different ages, cultures, and subgroups (Haidt, Rozin, McCauley, & Imada, 1997). For example, people may express social-moral disgust to signal their disapproval of behaviours that violate social norms or to distance themselves from people who are considered tainted, diseased, or strange. In line with this, disgust can be interpreted as a sign of disapproval (Heuer, Lange, Isaac, Rinck, & Becker, 2010). Anxiously-attached individuals exhibited a strong and highly significant tendency to attend away from closed-mouth disgust faces, which have been associated with social rejection (Westphal, Bonanno, & Mancini, 2014) in comparison to securely attached individuals. However, the attending away from disgust faces, did not hinder the socially anxious in our study to show an enhanced mimicry of these expressions. As those whose facial expressions convey negative emotions (e.g., disgust) are viewed negatively by others (van Kleef, 2009), it should be further investigated if the stronger mimicry of disgust leads to the perception of HSA individuals as less likeable, sympathetic, or talkative (Alden & Wallace, 1995).

On the other hand, there were no group differences for the emotional mimicry of happiness, sadness, anger, and or anxiety. Our results differ from results of studies that compared people with different levels of fear of public speaking. People high in fear of public speaking showed less mimicry of happy expressions (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004) and either less (Dimberg & Christmanson, 1991) or more (Dimberg, 1997; Dimberg & Thunberg, 2007; Vrana & Gross, 2004) mimicry of anger. However, these results are based on static facial expressions that might be more limited in

ecological validity than the dynamic expressions used in our study. Furthermore, the use of pictures of facial expression from same age individuals might have enhanced mimicry reactions in our sample (Ardizzi et al., 2014). In the current study, better emotion recognition was associated with more mimicry of anxiety, but not of other emotions. It remains an open question if emotional mimicry facilitates emotion recognition, as suggested by Niedenthal et al. (2010).

9.2.2 Emotion Perception in Socially Anxious Individuals

Regarding group differences, only a tendency ($p = .07$) toward worse emotion recognition of negative facial expression in HSA compared to LSA participants emerged in our study. This is in line with previous studies where recognition accuracy did not differ between socially anxious participants and healthy controls (Arrais et al., 2010; Bell et al., 2011; Campbell et al., 2009; Joormann & Gotlib, 2006; Leber et al., 2009; Philippot & Douilliez, 2005; Stevens et al., 2008), but it is in contrast to an enhanced recognition of all facial expressions (Hunter et al., 2009) and of negative expressions (Foa et al., 2000; Lundh & Ost, 1996; Winton et al., 1995) in HSA compared to LSA individuals. In our study, the overall recognition accuracy was high and we had to exclude the conditions happiness and neutral from analyses because of ceiling effects. To avoid ceiling effects, future studies might include more positive emotions and a dynamic presentation of the neutral condition, for example, with opening and closing the mouth. Therefore, in the facial morphing task of the main study, the neutral facial expressions were presented with opening and closing of the mouth.

We had an equal sex distribution across groups, but in both groups more women participated. This could have influenced the recognition accuracy since women have been shown to be better in emotion recognition than men (Hall & Matsumoto, 2004). Whereas most of the studies done so far used black-and-white static stimuli (Arrais et al., 2010; Campbell et al., 2009; Joormann & Gotlib, 2006; Leber et al., 2009; Philippot & Douilliez, 2005; Winton et al., 1995), we used gradually changing dynamic colour pictures in order to more closely simulate dynamic facial expressions as they might occur in daily life, to raise ecological validity. The two previous mimicry studies using dynamic facial expressions (Bell et al., 2011; Joormann & Gotlib, 2006) used morphing presentation times longer than 25 s that may have appeared to be too slow and thus unnatural to participants. This may explain some of the divergent findings between their studies and ours.

9.2.3 The Influence of Mood

Previous studies did not control for mood, despite its effect on emotion recognition (Mullins & Duke, 2004) and emotional mimicry (Moody et al., 2007). In our study, a neutral mood was induced with a documentary film. Nevertheless, after mood induction HSA participants still indicated that they experienced a higher amount of excitement and arousal than LSA participants. However, correlational analyses indicated no systematic effect of these emotional states on mimicry and recognition performance. It is well known that participants with high anxiety-related traits react more anxiously to novel laboratory environments with an unknown experimenter. This constitutes a particular challenge in emotion research that might require the use of ambulatory assessment technologies to be circumvented (Wilhelm & Grossman, 2010).

9.2.4 Emotion Regulation in Socially Anxious Individuals

Regarding emotion regulation difficulties, HSA participants reported having more trouble accepting their feelings and having limited access to emotion regulation strategies. These questionnaire findings are in line with results of previous studies (Mennin et al., 2009; Rusch et al., 2012) and together with the altered emotional mimicry suggest that including emotion regulation training that addresses socio-emotional mimicry in cognitive-behavioural treatment of social anxiety may be beneficial to patients. As in the Rusch et al. (2012) study, HSA participants reported more impulse control difficulties. Experiencing uncontrollable anxiety might enhance the impression of having no control over the situation as a whole (Rusch et al., 2012). Unlike in previous studies using the same questionnaire (Mennin et al., 2009; Rusch et al., 2012), HSA participants in our study also reported a lack of emotional clarity, indicating confusion caused by emotions. However, we found no association between emotion regulation and emotion recognition in others. Further, emotion regulation difficulties were associated with less mimicry of anxiety, but not with other emotions.

9.2.5 Limitations and Strengths

Several limitations of the current study have to be considered. First, our study has a limited generalizability, since the sample consisted of a subclinical socially anxious group. However,

since eight HSA individuals were above an accepted clinical cut-off score for social anxiety on the SPS (according to Heinrichs et al., 2002), it is likely that some of the results generalize to clinical samples. Stopa and Clark (2001) indicated that the results from analogue studies are typically similar to those of clinical studies. Due to the high comorbidity of SAD, for example, with depressive disorders, it will be important to describe the influence of different comorbid disorders on the capacity to recognize and regulate emotions. Second, in daily life, emotional expressions usually occur in social contexts, which could influence mimicry of these expressions and recognition ability. Therefore, more natural laboratory study designs are needed. Measuring mimicry during a conversation with a stranger may be a promising approach. And third, the relatively small sample size could be responsible for some nonsignificant findings. Fourth, for the analysis of the facial mimicry effect, we excluded the first two seconds due to a nonresponsiveness of the participants and barely detectable emotion. However, we were the first to investigate facial mimicry in socially anxious subjects with a broad variety of emotions. Furthermore, we simultaneously assessed emotion recognition and we analysed associations between emotional mimicry, emotion recognition and emotion regulation.

9.2.6 Conclusions and Implications

Results of the present study offer new ways to understand the underlying factors and mechanisms of social anxiety. The observed enhanced mimicry of disgust in HSA participants could be misinterpreted as disapproval and rejection of the conversational partner (Heuer et al., 2010). Most likely, the conversational partner will react to this rejection by expressing rejection. This could result in a vicious circle and constitute a self-fulfilling prophecy that contributes to the maintenance of social anxiety. Therefore, our results also suggest approaches for treatment. HSA individuals reported difficulties clarifying which emotions they feel and accepting their emotions. Recently, new techniques for supporting patients as they learn to access and handle their emotions were implemented. For example, acceptance and commitment therapy (ACT) has its main focus on helping patients accept their feelings. Indeed, in a recent review (Norton, Abbott, Norberg, & Hunt, 2015) significant improvements in social anxiety were demonstrated following mindfulness and acceptance based treatments but benefits were equivalent than yielded by cognitive-behavioural therapy (CBT). As emotion regulation strategies are neither maladaptive nor adaptive, but should be considered within the context and goals in a given

situation (Aldao & Nolen-Hoeksema, 2012), future studies should try to study emotion regulation processes under consideration of the outcome of specific situations. Electronic momentary assessment of emotion regulation in situations, in which social anxiety is likely to be activated, might provide an option. It remains to be seen if it is helpful to add emotion recognition and expression training to existing treatments.

9.3 Discussion Main Study 1: Diagnostic and Clinical Correlates of NSSI

We examined the proposed *DSM-5* criteria for an NSSI disorder in a female inpatient adolescent sample and investigated diagnostic and clinical correlates of NSSI, comparing adolescents with NSSI disorder, adolescents with NSSI without impairment/distress, adolescents with mental disorders without NSSI, and adolescents with no mental disorders. The results indicated that with the currently proposed *DSM-5* criteria for an NSSI disorder, a sample of adolescents could be identified who were more impaired than adolescents who were also hospitalized due to mental disorders but did not engage in NSSI. In addition, 80% of the adolescents with NSSI disorder did not meet criteria for BPD, supporting the evidence for a distinct diagnostic entity.

9.3.1 Examination of the Diagnostic Criteria for NSSI

For the proposed *DSM-5* diagnostic criteria for NSSI disorder, in criteria B (intentional injury is associated with at least two of four symptoms) the highest frequency of agreement was for psychological precipitant, especially sadness and tension, and contingent response, especially relief from negative feelings. The lowest agreement was for preoccupation with the behaviour. Results are in line with a community study (Zetterqvist, et al., 2013), although they assessed criterion B1 (psychological precipitant) with two items of the FASM and we asked which feelings they experienced just before self-injuring. As in the Zetterqvist et al. (2013) study, in our sample there were some ($n = 12$, 29% of adolescents of the NSSI group) who fulfilled the NSSI criteria A, B, D, and E but denied that the behaviour caused them any impairment or distress. In an attempt to better operationalize the impairment/distress criterion, in the structured diagnostic interview Kinder-DIPS (Margraf, Schneider, & Unnewehr, 2009) there is an additional question: “Do you want help for this problem?” Whereas distress was reported by 69% of adolescents with NSSI disorder, a desire for help was affirmed by 80% and also by 30% of adolescents who denied having impairment or distress due to NSSI. When we compared the

NSSI and NSSI-C groups, we found significantly less automatic positive and negative reinforcement as functions of NSSI in the NSSI-C group. Adolescents with NSSI without impairment or distress might have higher spontaneous recovery rates, as NSSI is hypothesized to be perpetuated through positive and negative reinforcement processes (Nock, 2009). Furthermore, the NSSI-C group did not fulfil criteria for BPD, had fewer externalizing disorders, and, although not significant, showed a trend of reporting fewer depressive and borderline symptoms and fewer difficulties in emotion regulation. Future research using larger sample sizes should elaborate on this issue.

9.3.2 Methods Used for NSSI

The most common methods used for NSSI were cutting, carving, and scraping. This is in accordance with related literature (Lloyd-Richardson, et al., 2007; Nixon, et al., 2002; Sornberger et al., 2012; Whitlock, Eckenrode, & Silverman, 2006; You et al., 2015). In DSM-5 (APA, 2013) the method “picked at a wound” was excluded, as it is endorsed by too many persons who otherwise never injure themselves (Lloyd-Richardson, et al., 2007; Zetterqvist, et al., 2013). In our sample, this method was also endorsed by 22% of adolescents in the non-clinical group. We were unable to differentiate between adolescents performing minor and moderate/severe NSSI methods due to a huge overlap. In the sample with NSSI disorder, the mean number of types of NSSI performed was 5.42, mean age of onset was 13 years, and 12% had received medical treatment. NSSI is mostly an impulsive behaviour that 87% of the adolescents with NSSI disorder reported not thinking about at all or in the few minutes before engaging in NSSI.

9.3.3 NSSI and Diagnostic Correlates

As far as we know, this is the first study using clinical structured interviews and the suggested *DSM-5* criteria for NSSI to examine diagnostic correlates. Findings suggest that NSSI is comorbid with a wide range of diagnoses. The most common comorbid diagnoses were major depression, PTSD, and social phobia, supporting the results of others (Hintikka et al., 2009; Nock, et al., 2006) and a review by Nitkowski and Petermann (2011). Results are also in line with the chart review of inpatient adults with NSSI (Selby, et al., 2012) characterized by high

rates of internalizing disorders like depressive and anxiety disorders. All but one subject had at least one Axis I disorder in the Selby et al. (2012) study; similarly, in our sample there were two adolescents with NSSI disorder without any comorbid diagnosis. The comorbidity with externalizing disorders would probably even be higher if the recruitment of this study would not focus on inpatient psychiatric adolescents as in Switzerland female adolescents with externalizing disorders are often placed in residential group homes with outpatient psychiatric and psychotherapeutic services.

Our finding of a prevalence rate of 20% of adolescents with NSSI disorder also fulfilling diagnostic criteria for BPD corresponds to some studies (Crowell, et al., 2012; Herpertz, Sass, & Favazza, 1997; Nitkowski & Petermann, 2011), but is lower than the rate of 50% reported by Nock et al. (2006). The least frequently endorsed criteria of the borderline symptoms were identity disturbances and paranoid/dissociative symptoms. Exploring different borderline features might be interesting, as a longitudinal study showed that behavioural impulsivity was an important symptom in explaining frequency of NSSI, low level of affective instability acted as a protective factor, and an unstable sense of self was less helpful in explaining the presence and initiation of NSSI among adolescents (You et al., 2012). Dimensionally, adolescents with NSSI disorder were not significantly different from adolescents with BPD, although the scores of the adolescents with NSSI without BPD were lower, and for the BSL-95, below the clinical cut-off. Because self-injurious behaviour is a criterion of BPD, there can be an association of NSSI and BPD; however, the current results indicate that NSSI disorder can be present without BPD. Nevertheless, future research has to investigate if adolescents with NSSI might develop additional BPD symptoms over time. Other than BPD, no other personality disorders were diagnosed in this sample. There may be a hesitancy to assign personality disorders in this age group (Schmid et al., 2008).

In light of previous studies (Hintikka, et al., 2009; Nock, et al., 2006; Zetterqvist, et al., 2013), a somewhat unexpected result was the low rate of alcohol and substance abuse or dependence. There was one adolescent with NSSI disorder fulfilling criteria for present substance abuse. On the interview on NSSI and in the FASM, three adolescents reported sometimes self-injuring under the influence of alcohol or drugs. One explanation of these results might be that the present sample was inpatient adolescents and therefore they did not have the opportunity to use drugs or alcohol on a regular basis. Furthermore, alcohol use in Switzerland is

legal starting at age 16 (beer, wine) or 18 (all alcoholic beverages), respectively, that cultural differences might influence the results on an abuse in adolescents. However, similar to in other studies (Nock, et al., 2006; Zetterqvist, et al., 2013), 54% of the NSSI group endorsed smoking regularly, compared with 10% of the CC group.

9.3.4. NSSI and Suicidality

The majority (69%) of adolescents with NSSI disorder reported a suicide attempt, which is in line with the 70% found in the study by Nock et al. (2006). As all adolescents with NSSI disorder endorsed that they conducted NSSI without suicidal intent, NSSI has to be distinguished from suicidal behaviour. This is also supported by the reports of some (18%) adolescents with NSSI disorder indicating that they engaged in NSSI to prevent a suicide attempt. Nevertheless, there is considerable overlap between NSSI and suicidal behaviour. In two prospective studies, NSSI was shown to be a significant predictor for suicide attempts (Asarnow, et al., 2011; Klonsky, et al., 2013; Whitlock, et al., 2013). In our study, adolescents with NSSI disorder reported a mean age at onset of NSSI of 13 years, a mean age of 12 years for suicide ideations, and a mean age for the first suicide attempt of 14 years. This would be in line with Joiner's interpersonal theory of suicide (Joiner, 2005) that attempting suicide requires both the desire and the capability to attempt suicide, and NSSI correlates with both. NSSI raises capability by allowing individuals to habituate to self-inflicted pain and violence (Nock, et al., 2006) and it heightens risk for suicidal desire through association with emotional and interpersonal distress (Klonsky, Oltmanns, & Turkheimer, 2003; Whitlock, et al., 2013). Indeed, there is evidence, that self-injuring frequency is strongly associated with suicidality (Andover & Gibb, 2010, Paul et al., 2015), but it remains object of further investigation if these associations can also be shown in adolescents with NSSI disorder, as all of them already injured themselves at least five times. It is essential to identify why and how NSSI heightens the risk for suicide attempts.

9.3.5 Conclusion and Implications

In addition to the diagnostic correlates, clinical correlates indicated that adolescents with NSSI disorder have, compared with adolescents with mental disorders without NSSI and in line with previous research, elevated rates of internalizing and externalizing symptoms (Csorba, et al.,

2009; Nixon, et al., 2002), low functioning (Selby, et al., 2012), and difficulties in emotion regulation (Gratz & Tull, 2011). These findings complement the picture of highly impaired adolescents with NSSI disorder.

Implications of these results are that a precise and comprehensive diagnostic assessment including NSSI should be conducted routinely; On one side, NSSI is a highly impairing disorder on its own for the patients themselves, relatives and friends, and on the other side, it is also a risk factor for suicidal behaviour. In summary, our study suggests that the proposed *DSM-5* criteria for NSSI are useful and necessary to promote research on aetiology, course, and the development of effective treatment strategies and interventions for adolescents suffering from NSSI.

9.4 Discussion Main Study 2: Personality in Adolescents with NSSI

The aim of the present study was to investigate personality traits on the basis of Cloninger's (1987) personality model, with a special focus on impulsivity in adolescents with NSSI without BPD, adolescents with NSSI and BPD, a clinical and a nonclinical control group.

9.4.1 NSSI and Personality

As expected, the groups showed distinct personality features. Adolescents with NSSI scored higher on novelty seeking and harm avoidance and lower on self-directedness, persistence and cooperativeness than clinical controls.. In adolescents with NSSI and BPD this personality pattern was even more pronounced than in adolescents with NSSI without BPD. Therefore, we were able to replicate the highly impairing personality pattern consisting of high harm avoidance and novelty seeking in adolescents with BPD as shown by Cloninger (2002) and Kaess et al. (2013). Furthermore, we extended these findings to adolescents with NSSI disorder according to *DSM-5* without BPD, but in these patients the personality pattern is less pronounced. As adolescents with NSSI-BPD show a similar personality pattern as adolescents with NSSI+BPD, even if they do not fulfill all criteria for BPD, a dimensional personality model useful to better describe and understand adolescents with NSSI-BPD and to prevent further impairment in personality functioning. Most experts are supporting the dimensional personality model (Bernstein, Iscan, & Maser, 2007). Harm avoidance scores of adolescents with NSSI were above

cut off for normal personality functioning, representing an extremely pronounced personality pattern

We were able to replicate a lower level of self-directedness in adolescents with NSSI than adolescents without NSSI similar to Hefti et al. (2013) and Joyce et al. (2010). In contrast to Ohmann et al. (2008), we found lower levels of cooperativeness in adolescents with NSSI compared to adolescents without NSSI, but this result is similar to the low level of cooperativeness found in adolescents with BPD (Brown, 2009). Low cooperativeness may cause more interpersonal conflict and distress. In fact, previous research indicates that adolescents with NSSI frequently reported problems in social interactions (Adrian et al., 2011). Low levels of self-directedness and cooperativeness, as we found in adolescents with NSSI, are seen as core characteristics of individuals with personality disorders (Cloninger, 2000) and therefore might represent a pathological personality trait. The low level of persistence in adolescents with NSSI is consistent with findings, that adolescents with NSSI give up faster pursuing goals, while adolescents without NSSI are more diligent and persevering (Goth & Schmeck, 2009), but not with previous research (Hefti et al., 2013; Joyce et al., 2010; Ohmann et al., 2008). All groups were similar regarding self-transcendence, therefore we could not find supporting evidence for a higher self-transcendence like previously reported in adolescents with SIB (Hefti et al., 2013) and adolescents with BPD (Barnow et al., 2005).

We can summarize that there is a clear difference in personality traits between adolescents with NSSI+BPD and adolescents with NSSI-BPD, despite the small NSSI+BPD sample size ($n = 14$), as well as between adolescents with NSSI and adolescents with other mental disorders, indicating significantly more difficult temperament and more impairment in personality functioning in adolescents with NSSI than in adolescents with other mental disorders.

9.4.2 NSSI and Impulsivity

As adolescents with NSSI (-BPD and +BPD) show more novelty seeking than CC, it is not surprising, that they scored higher on all subscales of the Barratt Impulsiveness Scale (attentional, nonplanning, and motor impulsivity). However, this difference was not evident in the Go/ No Go task. Neither a group effect, nor a facial emotion effect emerged in the Go/ No Go task. Happy faces were associated with faster reactions and a lower error rate compared to angry faces, indicating that happy faces are easier to discern than angry faces. Our results are in

line with several other studies that found more self-reported impulsivity in adolescents (Fikke et al., 2011; Janis and Nock, 2009) or adults with NSSI behaviour (Glenn & Klonsky, 2010; McCloskey et al., 2012), but lacked to show this difference on behavioral measures. However, this discrepancy is not solely observed in adolescents with NSSI, but represents a general difficulty in the measurement of impulsivity which may be explained by the measurement of different impulsivity constructs (Mc Closkey et al., 2012). 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). As questionnaires usually measure impulsivity in emotional situations, adolescent with NSSI might only react impulsive in emotional situations or when they are in a negative mood. But so far, lab-based studies have not included mood manipulations prior to assessing behavioural measures of impulsivity (for a review see Hamza et al., 2015). By measuring impulsivity in an emotional stop signal task Allen & Hooley (2015) found adolescents with NSSI to be more impulsive only in response to pictures of negative emotional situation, but not to pictures of neutral emotional situations. However, we were not able to show group differences in impulsivity in response to angry, happy, and neutral facial expressions. The reason for this discrepancy remains to be clarified by further studies. Adolescents with NSSI+BPD reported even more impulsivity than adolescents with NSSI without BPD, especially more nonplanning impulsivity (lack of future orientation and foresight), but again this difference was not evident in the Go / No Go task.

9.4.3 Limitations and Strengths

The results of the present study should be interpreted in the context of some limitations. The design of the study was cross-sectional. Therefore, the current study cannot explain if certain personality traits might favor the development of NSSI disorder. This has to be investigated in future prospective longitudinal studies. Nevertheless, results indicate an association between personality traits and NSSI. Further studies should include equally distributed samples of adolescents with NSSI+BPD and NSSI-BPD. But despite the small NSSI+BPD sample size in this study, significant differences emerged between NSSI+BPD and NSSI-BPD. The relatively small number of clinical control adolescents can be explained by the high prevalence rates of NSSI (30-61%) in inpatient samples (Kaess et al., 2013; Nock & Prinstein, 2004). Our sample

consisted of female adolescents admitted to a psychiatric unit and therefore generalizations to other samples must be made with caution. A further limitation is the use self-report measures, only for one aspect of novelty seeking, impulsivity, an experiment was conducted. Considering the low error rate, the Go/No Go task used to assess impulsivity might have been too simple. Future studies should use less intense emotional facial expressions (< 100%) and a higher Go stimuli to No Go stimuli ratio to increase the respond pressure.

Strengths of this study were the use of the *DSM-5* diagnostic criteria for NSSI disorder in a clinical sample. In addition, a clinical control group of adolescents with other mental disorders without NSSI were included. This allowed us to identify personality traits specific to NSSI disorder. To our knowledge, this is the first study to compare personality traits in adolescents with NSSI+BPD and adolescents with NSSI-BPD and especially in an inpatient setting this comparison is a particular strength of the study.

9.4.4 Conclusions and Implications

Given the differences in personality traits between adolescents with NSSI+BPD and adolescents with NSSI-BPD a personality assessment using the JTIC (Goth & Schmeck, 2009) might be useful for the diagnostic distinction between adolescents with NSSI with and without BPD. A clear distinction of these two groups might help choosing a specific treatment and the adequate treatment intensity for adolescents engaging in NSSI. So far, there is a lack of specific treatment programs for adolescents with NSSI. The development of such specific treatments with lower intensity than the common treatments for BPD (e.g. Dialectical Behavior Therapy, Linehan, 1993) may not only optimize treatment, but also reduce treatment costs because maybe fewer therapy sessions are required. The prognostic significance of personality for the development of NSSI and BPD has to be further examined in longitudinal studies. If confirmed, the assessment of personality traits could help identify adolescents at high risk for the development of NSSI. This would allow indicated specific prevention programs. The need to develop more effective and targeted prevention and intervention initiatives for personality disorders was highlighted by Grant et al. (2004). Similarly the identification of adolescent with NSSI at high risk for the development of a BPD could help to get them into specific treatments. Early intervention with specific treatments prevents chronification (Chanen et al. 2008). Especially Cloninger's character traits (self-directedness, cooperativeness, and self-transcendence) offer a basis for resource-

oriented interventions. So far, there are no psychological programs promoting character development in accordance to Cloninger's personality model (1987), but an existing program focuses on similar aspects, for example problem-solving or conflict resolution (Witt et al., 2014). Future studies should investigate the long-term influence of psychotherapy on character and temperament traits and the possibility to improve quality of life and reduce psychopathology through personality changes.

9.5 Discussion Main Study 3: Emotion Recognition in Adolescents with NSSI

Main study 3 investigated if adolescents with NSSI compared to adolescents with mental disorders without NSSI and adolescents without mental disorders differed in their capacity and accuracy in recognizing emotions in dynamic facial expressions following a negative and neutral mood induction.

9.5.1 NSSI and Emotion Recognition

The results of this study indicate that adolescents with NSSI have no general deficits in accurately recognizing emotional facial expressions. There were no group differences in the intensity of emotion required for participants to correctly identify happy, sad, angry, disgusted, fearful, or neutral facial expressions. In addition, there were also no group differences in the accuracy of emotion recognition. Our results might indicate that adolescents with NSSI in general possess basic social skills, such as facial emotion recognition. However, the question remains if these skills can be used in stressful situations and in situations with specific triggers. Therefore, further research on emotion regulation in difficult social interactions and in different mood states is of interest.

Due to the lack of studies with adolescents with NSSI, we have relied on studies investigating adolescents with BPD or borderline personality symptoms to discuss our results. However, caution is warranted when comparing these groups, as several studies have indicated differences between patients with NSSI and those with BPD (Glenn & Klonsky, 2013; In-Albon et al., 2013; Bracken-Minor & McDevitt-Murphy, 2014). Jovev et al. (2011) found that in a facial morphing task, youth with borderline personality symptoms and controls required comparable levels of emotional detection to correctly identify emotions, results consistent with

our own, and the two groups also showed no evidence of heightened sensitivity, that is, the ability to recognize emotion at lower levels of intensity. Jovev et al. (2011) suggested that emotional sensitivity is present only in severe BPD or develops later in the course of the disorder, possibly through continuing exposure to traumatic life events and recurrent mental disorders (Jovev & Jackson, 2006). Support for the explanation that emotional sensitivity might be present only in severe BPD is somewhat lessened, as the present subjects with NSSI were highly impaired with a mean of 3.36 diagnoses and a mean time using NSSI of 4 years. In adolescents with BPD, Robin et al. (2012) found no impairment in identifying fully expressed emotions, but in contrast to our results, they found higher recognition thresholds for facial expressions of anger and happiness than in controls. In adults with BPD results are inconsistent, as well (see also Mitchell et al., 2014 for a meta-analysis). Domes et al. (2008) found no general deficit in their affect recognition tasks. For ambiguous emotional stimuli, they found a bias toward the perception of anger. Yet Lynch et al. (2006) found that adults with BPD correctly identified facial affect at an earlier stage than did healthy controls, regardless of the valence of the expressed emotion. Methodological differences might explain the discrepant results of the Lynch et al. (2006) study, as participants could change their responses as often as they wanted until the end of the expression. In all other studies, each trial was stopped following the first response, which could not be altered. Some differences exist in the procedures of the emotion recognition tasks in the various studies; in the studies by Jovev et al. (2011) and Domes et al. (2008), faces were morphed in 5% steps, compared to 2.5% steps in Robin et al. (2012) and 2% steps in the present study. Therefore, the presentation steps of the facial expressions cannot explain the differences in study results. All except the present study used the adult black-and-white Ekman and Friesen (1976) pictures. At the current state of research, the inconsistent emotion recognition findings cannot be adequately explained because of differences in methods or different clinical samples, as previous studies did not include a clinical control group. Clearly, more research is needed that investigates different clinical samples with different, validated methods and stimuli.

9.5.2 Interpretation of Neutral Stimuli

Neutral facial expressions were not interpreted more often as negative. Neutral facial expressions were also shown dynamically, morphing from a neutral expression with closed mouth to a

neutral expression with a slightly open mouth and back to the closed mouth (as the NimStim data set consists of emotional facial expressions with both closed and open mouths). This was done since the neutral static expressions were easy to detect. There is only one other study that presented neutral facial expressions to adolescents with BPD; von Ceumern-Lindenstjerna et al. (2007) presented neutral facial pictures on paper. Similar to our findings, their results indicated no dysfunctional interpretation of neutral expressions.

9.5.3 Effects of Psychotropic Medication

In the present study, in the NSSI group a significant effect of psychotropic medications was found on the first correct response of the stimuli that with medications the adolescents with NSSI required significantly more stages to correctly recognize the stimuli compared to adolescents with NSSI without medications. In the study by Domes et al. (2008) no effect of medication on detection threshold and accuracy was found in adults with BPD and in the study by Lynch et al. (2006) also with adult patients with BPD although the effect of medication on emotion recognition was nonsignificant, there was a medium effect size that unmedicated participants with BPD correctly identified facial emotion slightly earlier than medicated participants with BPD. However, our results are consistent with Coupland, Singh, Sustrik, Ting, and Blair (2003) found a significant effect of diazepam on the recognition of emotional expressions and in recognition accuracy. As there was no difference between the adolescents with NSSI with and without psychotropic medications on the YSR total score, other variables might be responsible for the difference indicating that the effect of medications has further to be investigated as Mitchell et al. (2014) stated in their review on facial emotion processing that medication and psychological treatment status is rarely considered.

9.5.4 Effects of the Mood Induction

Sad mood had no significant effect on the results, neither for facial emotion recognition nor for accuracy, even though, and in line with results of previous studies (Bolten & Schneider, 2010; Joormann et al., 2010), mood induction was successful and participants endorsed more sadness after watching the negative film clip and showed no mood change after watching the neutral film clip. In contrast, Schmid and Schmid Mast (2010) found a negative bias for participants in a sad

mood and a positive bias for participants in a happy mood, and Moody et al. (2007) found that fear induction increased attribution of fear to angry faces. However, as far as we are aware, our study is the first to investigate the influence of mood induction on emotional facial recognition in clinical samples. Further research on mood influences is certainly necessary, especially to describe the specific influence of mood induction with various emotions on different emotions.

9.5.5 Ratings of Facial Expressions Valence and Arousal

Regarding the valence and arousal ratings, adolescents with NSSI rated the neutral and happy facial expressions as more unpleasant and the angry, sad, and happy facial expressions as more arousing than the nonclinical control group. Similarly, Jovev and colleagues (2011) also found that youth with borderline symptoms rated happy emotions as less positive compared to a community group and in female adolescents with BPD, however, they did not control for psychopathology. Controlling for psychopathology the present results indicated that higher psychopathology has an influence on valence and arousal ratings, however for arousal there was still a significant main effect of group and a borderline main effect of group for valence. Von Ceumern-Lindenstjerna et al. (2007) found that positive facial expressions were rated as more negative compared to healthy controls. The negativity of positive facial expressions was influenced by actual mood and depressive symptoms, but not the trend to interpret positive facial expressions as negative. Therefore, the role of the actual mood and psychopathology has clearly to be investigated in further studies. These results indicate that although adolescents with NSSI adequately recognize the emotion happiness, they interpret the positive emotional expression as more unpleasant and more arousing. The information processing of positive emotions and its role in emotion regulation should be investigated in future studies, especially regarding the specificity to NSSI disorder, as we found no significant difference between adolescents with NSSI and the clinical controls, and previous studies did not include a clinical control group.

9.5.6 Limitations and Strengths

Some limitations of the current study need to be acknowledged and should be addressed in future studies. The sample consisted of female adolescents admitted to an inpatient child and adolescent psychiatric unit and thus the results may not generalize to other samples. Therefore, male

adolescents with NSSI should be included in further studies. In general, females perform better in recognition tasks than males (McClure, 2000). The presentation of pictures of facial expressions is of course not a real-life social interaction. The assessment of emotion recognition in daily social interactions would be of higher ecological validity and therefore would be an important next step for future studies. Furthermore, it will be important to describe the influence of comorbid disorders as the clinical control group was very heterogeneous. Finally, further research is needed to replicate these findings. Strengths of our study were the inclusion of a clinical control group, the use of several dynamic emotional facial expressions with colour stimuli, the use of the morphing technique with 2% steps of intensity, and the use of *DSM-5* (APA, 2013) research criteria for NSSI.

9.5.7 Conclusions and Implications

If replicated, our finding that adolescents with NSSI have no deficits in emotion recognition could mean that in treatment, a focus on emotion recognition is not strictly necessary. As mentioned before, the ability to correctly identify facial emotion stimuli should be confirmed, for example, in everyday social interactions or in stressful situations and in situations with specific triggers. Furthermore, although adolescents with NSSI do not have difficulties recognizing facial emotions in others, we do not yet know how well they recognize their own emotions or how they react to emotional facial expressions. The correct identification of one's own emotions might be a crucial step in emotion regulation. If replicated, our results indicate that the difficulties adolescents with NSSI endorse in social relationships are not likely to be the result of an inability to identify others' emotional states. Therefore further research on interpersonal difficulties is warranted.

In summary, this is the first study on dynamic emotional facial recognition in adolescents with NSSI. The results of the present study demonstrate an accurate recognition ability of emotional facial expressions in female adolescents with NSSI and a lower valence rating of positive facial expressions.

10. References

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Appendices

A: Publication 1

B: Publication 2

C: Publication 3

D: Publication 4

E: CD-Rom

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Running Head: Emotion Regulation in Social Anxiety

Emotion regulation in high and low socially anxious individuals: An experimental study investigating emotional mimicry, emotion recognition, and self-reported emotion regulation

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Abstract

Emotion recognition and emotional mimicry are both important for social interactions. In socially anxious individuals, difficulties in emotion recognition or emotional mimicry might lead to fear of negative evaluation. The authors investigated if high socially anxious (HSA) individuals show an altered pattern of emotional mimicry, exhibit difficulties in emotion recognition, and indicate more difficulties in self-reported emotion regulation compared to low socially anxious (LSA) individuals. Twenty-one HSA and 20 LSA participants were exposed to 60 dynamic facial expressions that gradually changed from neutral to full-intensity expressions of happiness, anger, sadness, disgust, or anxiety. Emotional mimicry was assessed using facial electromyography. Emotion recognition was measured after every picture and emotion regulation was measured by self-report. Results confirm emotion-specific emotional mimicry patterns for all five emotions. HSA participants mimicked disgust significantly more than LSA participants. Moreover, HSA participants showed a tendency toward impaired emotion recognition of negative facial expressions ($p = .07$) and reported more emotion regulation difficulties on the Difficulties of Emotion Regulation Scale. Results convey subtle alterations in emotional mimicry in HSA individuals and indicate that they may benefit from targeted emotion regulation training.

Keywords: affect; emotion regulation; facial mimicry; social anxiety; emotion recognition

Emotion regulation in high and low socially anxious individuals: An experimental study investigating emotional mimicry, emotion recognition, and self-reported emotion regulation

Social Anxiety Disorder (SAD), a marked fear or anxiety about one or more social situations in which the individual is exposed to possible scrutiny by others (American Psychiatric Association, 2013), is related to clinically significant impairment in social, occupational, and other important areas of functioning. Social anxiety is a construct that is particularly debated regarding the distinction between dimensional and categorical descriptions of psychopathology (Potuzak, Ravichandran, Lewandowski, Ongür, D., & Cohen, 2012; Wright et al., 2013). On the one hand, symptoms of social anxiety are common even in high-functioning community samples, while on the other hand, SAD is a mental disorder with high impairment (Bögels et al., 2010) and is associated with reduced social interactions and impaired social support (Katzelnick et al., 2001). So far, treatment for SAD has not been as successful as treatments for other anxiety disorders, indicated by a moderate treatment effect for SAD compared to good effects for all other anxiety disorders (Stewart & Chambless, 2009). Therefore, improvements in the treatment of SAD are necessary. A better understanding of emotion perception and emotion regulation in high socially anxious individuals might be an important step in developing more successful treatments. Studies have indicated that poor or inflexible emotion regulation is associated with or possibly even causal for the development of anxiety disorders (Blair & Coles, 2000; Eisenberg et al., 2001).

Following Gross (2002, p. 282), most contemporary research defines emotion regulation as the processes by which individuals influence which emotions they have, when they have them, and how they experience and express them. Patients with SAD compared to controls previously reported more difficulties identifying and describing feelings (Cox, Swinson, Shulman, & Bourdeau, 1995; Fukunishi, Kikuchi, Wogan, & Takubo, 1997; Turk, Heimberg, Luterek, Mennin, & Fresco, 2005). One reason for difficulties in identifying emotions could be a

lack of awareness. Indeed, high socially anxious (HSA) individuals have been found to pay less attention to their emotions than low socially anxious (LSA) individuals (Turk et al., 2005). In addition, HSA individuals indicated a poorer ability to access effective emotion regulation strategies (Mennin, McLaughlin, & Flanagan, 2009; Rusch, Westermann, & Lincoln, 2012), impulse control difficulties (Rusch et al., 2012), and problems accepting their emotions (Mennin et al., 2009; Rusch et al., 2012). Furthermore, HSA individuals expressed less positive emotions than LSA individuals (Turk et al., 2005).

For successful interactions with others, emotional mimicry and the recognition of others' expressed emotions are highly important. Similar to the definition of Hess and Fischer (2013), our definition of emotional mimicry is the imitation of the emotional facial expression of another person. Mimicking behavior could be the key to a successful interaction. It fosters affiliation and liking and has been referred to as "social glue" (Lakin, Jefferis, Cheng, & Chartrand, 2003). Smiles are generally perceived as more relationship promoting than frowns or disgusted faces (Hess, Blairy, & Kleck, 2000; Knutson, 1996) and angry faces are signals for a lack of affiliative intent. Therefore, the imitation of positive emotions is more likely to foster affiliation and liking in an interactional partner than the imitation of negative emotions.

To our knowledge, only one group has investigated mimicking behavior and social anxiety. Vrijssen, Lange, Becker, and Rinck (2010) found that HSA individuals showed less observed mimicry of the head movements of a computerized avatar in comparison to LSA individuals. Emotional mimicry, however, has so far not been investigated in HSA individuals, but only in people with fear of public speaking, a specific aspect of the more generalized concept social anxiety. People with high fear of public speaking show less mimicry of happy expressions than people with low fear (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004). The results for the mimicry of angry expressions, in contrast, were inconsistent. Whereas Dimberg and Christmanson (1991) found less mimicry,

others found higher mimicry in individuals high in fear of public speaking (Dimberg, 1997; Dimberg & Thunberg, 2007; Vrana & Gross, 2004). Furthermore, individuals high in fear of public speaking showed more negative facial affects in reaction to neutral faces, which was interpreted as an anxiety reaction (Vrana & Gross, 2004). It is, however, difficult to compare the results of these studies because Dimberg and colleagues (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007) usually calculated difference scores between anger and happiness, while Vrana and Gross (2004) used the absolute muscle activity for each emotion. Moreover, Dimberg (1997) used a median split of the sample based on a questionnaire on fear of public speaking, while other studies (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004) used the highest and lowest 10–28% of students on such a questionnaire.

While these studies thus showed group differences for emotional mimicry between individuals high and low in fear of public speaking, fear of public speaking represents only one aspect of social anxiety. Therefore studies with generally socially anxious individuals are needed. Moreover, many aspects relevant to understanding facial mimicry in socially anxious individuals remain unresolved. For example, only Vrana and Gross (2004) included neutral facial expressions. Other important emotions such as disgust and sadness were not included in studies on fear of public speaking (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004). A recent review indicated that sufficient evidence exists only for the emotional mimicry effect of anger and happiness with their corresponding muscles *m. corrugator supercilii* and *m. zygomaticus major*, and not for disgust, anxiety, and sadness (Hess & Fischer, 2013). Therefore, confirmation of emotional mimicry effects for a variety of emotions is still necessary. Furthermore, while mood can affect emotional mimicry (Moody, McIntosh, Mann, & Weisser, 2007), none of the studies controlled for mood. Moreover, the stimuli used in the studies so far were only static pictures of emotional faces, but dynamic images have been shown to elicit a larger mimicry effect (Sato, Fujimura, & Suzuki, 2008).

It has been proposed that emotional mimicry facilitates emotion recognition because the facial muscles function as a feedback system for a person's own experience of emotion (Hatfield, Cacioppo, & Rapson, 1994). Indeed, blocking mimicry leads to a slower or less accurate recognition of happiness (Niedenthal, Mermillod, Maringer, & Hess, 2010). However, emotional mimicry studies did not confirm any relation between mimicry and emotion recognition (Fischer, Becker, & Veenstra, 2012; Hess & Blair, 2001).

The investigation of the recognition of emotional facial expressions in social anxiety could be crucial because facial expressions serve as an important interpersonal information source for knowledge of the internal emotional states of others (Phillips, Drevets, Rauch, & Lane, 2003). In addition, they contain information about positive or negative evaluations by others (Leber, Heidenreich, Stangier, & Hofmann, 2009) that are of particular importance to socially anxious individuals because of their fear of negative evaluation (American Psychiatric Association, 2013). Fear of negative evaluation has been proposed as one reason for enhanced attention to sources of potential social threat in SAD (Clark & Wells, 1995; Rapee & Heimberg, 1997). Indeed, a wealth of studies has demonstrated associations between social anxiety or SAD and attentional bias toward social threat (for a review see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). So far, studies on emotion recognition in SAD that examined the recognition of various facial emotional expressions have obtained mixed results. Some results suggest that there are no significant differences in recognition accuracy between individuals with SAD and healthy controls (Arrais et al., 2010; Bell et al., 2011; Campbell et al., 2009; Joormann & Gotlib, 2006; Philippot & Douilliez, 2005; Stevens, Gerlach, & Rist, 2008) and between HSA and LSA individuals (Leber et al., 2009). Hunter, Buckner, and Schmidt (2009) found a generally enhanced recognition of facial expressions in HSA compared to LSA individuals. Other studies found an enhanced recognition of negative compared to positive facial expressions in individuals with SAD (Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Lundh & Ost, 1996) and of negative compared to neutral facial expressions in

HSA but not in LSA individuals (Winton, Clark, & Edelman, 1995). Thus, previous studies have tended to produce evidence against impaired emotion recognition.

Some methodological issues have to be considered that might influence emotion recognition. Most of the mentioned studies used black-and-white static stimuli (Arrais et al., 2010; Campbell et al., 2009; Joormann & Gotlib, 2006; Leber et al., 2009; Philippot & Douilliez, 2005; Winton et al., 1995). Presentation times of the facial expressions varied from 60 ms (Leber et al., 2009; Winton et al., 1995) to 30 s (Foa et al., 2000) or were self-paced (Arrais et al., 2010), and therefore the results are difficult to compare. The two studies using dynamic facial expressions (Bell et al., 2011; Joormann & Gotlib, 2006) used presentation times longer than 25 s, which can look unnatural and produce results unrepresentative of daily life, because facial expressions typically change within seconds. Furthermore, previous studies did not control for mood, but mood, like emotional mimicry, can influence emotion recognition (Mullins & Duke, 2004).

For clinicians, it is important to know if patients with SAD have social skills deficits and therefore might benefit from social skills training. In a review, Levitan and Nardi (2009) stated that patients with SAD performed worse in social interactions and were rated by observers as less assertive and friendly, but when specific social skills were measured, there typically was no difference between patients with SAD and healthy controls. Maybe the social skills deficits are subtle and have not yet received sufficient scrutiny by research. An altered facial mimicry pattern could be responsible for the observed difficulties in social interactions and would point to specific interventions, such as emotion recognition and expression training.

Therefore, our goal with the present study was to extend previous research by investigating if social anxiety is related to altered emotional mimicry, emotion recognition, and emotion regulation. Participants classified as high or low in social anxiety watched dynamic facial expressions presented in color that changed from neutral to full-intensity expressions of

happiness, anger, sadness, disgust, and anxiety within 7 s (or stayed neutral, as a control condition). For the assessment of emotional mimicry, facial electromyography (EMG) signals of the *musculus (m.) zygomaticus major*, *m. corrugator supercilii*, *m. levator labii*, and *m. frontalis medialis* were recorded. Simultaneously, recognition of facial expressions was measured after each dynamic facial expression. The experiment controlled for the influence of mood by using a neutral mood induction. We hypothesized based on emotion regulation questionnaire data that HSA individuals would show more emotion regulation deficits and an altered pattern of emotional mimicry compared to LSA individuals. We expected to find further evidence for the emotional mimicry effect, not only for anger and happiness, but also for the less frequently investigated emotions anxiety, sadness, and disgust. Given the results of previous studies, we did not expect a substantial difference between the groups in emotion recognition.

Methods

Participants

Seventy-four subjects were invited from a pool of 143 subjects screened with the Liebowitz Social Phobia Scale (LSAS; Stangier & Heidenreich, 2005). Subjects were chosen for either the HSA group from those scoring in the top 25% or the LSA group from those scoring in the bottom 25%. Forty-one of the invited subjects participated in the experiment (HSA: $n = 20$; LSA: $n = 21$). The groups were comparable with respect to sex (LSA: 14 female, 6 male; HSA: 16 female, 5 male), $\chi^2(1) = 0.20, p = .66$, and age (LSA: $M = 25.75$ years, $SD = 6.31$; HSA: $M = 25.87$ years, $SD = 7.53$), $t(39) = -0.06, p = .96$. To confirm group differences in social anxiety symptoms indicated with the LSAS, $U = 420, p < .01$, participants in the experiment also completed the Social Interactions Anxiety Scale (SIAS; Mattick & Clarke, 1998; German translation: Stangier, Heidenreich, Berardi, Golbs, & Hoyer, 1999), which measures anxiety in social situations and interactions, as well as the Social Phobia Scale (SPS; Mattick & Clarke, 1998; German translation: Stangier et al., 1999), which

specifies the subtype of social phobia and measures anxiety in performance situations. As shown in Table 1, HSA participants scored significantly higher on the SIAS, $U = 390, p < .01$, and the SPS, $U = 392, p < .01$, than LSA participants. Six HSA participants on the SIAS (Mattick & Clarke, 1998; German translation: Stangier et al., 1999) and eight on the SPS (Mattick & Clarke, 1998; German translation: Stangier et al., 1999) had values above the clinical cut-off, as did all 20 HSA participants on the LSAS (Stangier & Heidenreich, 2005), using a cut-off score of 30 as suggested by Rytwinski et al. (2009).

Mood Induction and Emotional State

To ensure that all participants were in a similar, neutral mood before taking part in the experiment, we showed them part of a documentary on stars (03 min 22 sec) that has shown its efficacy in mood induction (Bolten & Schneider, 2010). After the film and after the mimicry paradigm participants indicated their current emotional state (arousal, excitement, anxiety, happiness, tension, sadness) on a 7-point Likert scale (1 = *not at all*, 7 = *very much*).

Emotion Regulation Measure

To assess difficulties in emotion regulation the Difficulties in Emotion Regulation Scale (DERS; Ehring, Tuschen-Caffier, Schnülle, Fischer & Gross, 2010; Gratz & Roemer, 2004) was used. The measure yields a total score and scores on six subscales (nonacceptance of emotional responses, difficulties engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, lack of emotional clarity). The internal consistency within the present sample was $\alpha = .92$ for the total score, and for the subscales it ranged from $\alpha = .73$ to $.87$.

Facial Mimicry Task

Stimuli. The facial stimuli were taken from the NimStim Face Stimulus Set (www.macbrain.org; Tottenham et al., 2009). Using a morphing technique similar to that in Sato

and Yoshikawa (2007), 60 facial expressions changing in 50 steps from a neutral expression to full-intensity emotion [happiness, sadness, anger, anxiety, disgust, neutral (i.e., no change, as a control condition)] were created using WinMorph 3.01. Each stimulus was presented for 140 ms with the software E-Prime (version 2.0) to create the impression of an animated clip of the progression of an emotional facial expression lasting 7 s.

Physiological measures. Electromyography (EMG) was performed according to the guidelines of Fridlund and Cacioppo (1986). The activity of the following muscles was recorded on the left side of the face: *m. corrugator supercilii*, *m. frontalis medialis*, *m. levator labii*, and *m. zygomaticus major*. As mentioned above, sufficient evidence exists only for the emotional mimicry effect of anger and happiness with their corresponding muscles *m. corrugator supercilii* (Dimberg, 1982) and *m. zygomaticus major* (Hjortsjö, 1970), and not for disgust, which is usually indexed by *m. levator labii* activity (Lundqvist & Dimberg, 1995), and anxiety, which should be related to *m. frontalis medialis* activity (Moody et al., 2007). More evidence exists for the imitation of sadness, but this emotion is also indexed by *m. corrugator supercilii* activity and hence it is unclear whether the displayed emotion is anger or sadness. Activation of this muscle can signal a negative mood, concentration, or bewilderment (Larsen, Norris, & Cacioppo, 2003). Therefore, we decided to measure the imitation of sadness with the *m. frontalis medialis*, similar to the procedure followed by Cram and Criswel (2010).

The measurement of the physiological data was conducted with a separate computer with the software AcqKnowledge (Biopac Systems, Inc., Goleta, CA, USA, 2003). Ag-Ag/Cl miniature electrodes filled with electrolyte were used for the recordings. The EMG was sampled at 1,000 Hz after anti-aliasing low-pass filtering at 500 Hz. To measure muscle activity magnitude, a 50-Hz notch filter, a high-pass filter (25 Hz), and, after signal rectification, a moving average filter with a window length of 50 ms were applied offline using ANSLAB software (Autonomic Nervous System Laboratory, version 4.0; Wilhelm & Peyk, 2005).

Procedure

The study was approved by the local ethics committee. All participants were informed of their rights as research participants and gave their written informed consent in accordance with the Declaration of Helsinki. They received course credit or a cinema voucher for their participation. Participants were seated in front of a computer and all physiological equipment was attached. The neutral mood induction film was shown. Afterward participants indicated their current emotional state. Then six practice trials (including all six emotions) were conducted. Before each morphing sequence of facial expressions (7,000 ms), a fixation cross appeared for 500 ms. After each morphing sequence a white screen appeared for 2,000 ms. Then participants were presented with a rating screen asking them to identify the emotion as happiness, sadness, anger, disgust, anxiety, or neutral. Before the start of a new sequence a white screen was shown for 2,000 ms. All six emotions were shown with five female and five male actors in a randomized order, which totals 60 sequences. The task took approximately 40 min. After the task participants indicated their current emotional states again. Electrodes were removed and participants were asked to complete the questionnaires.

Data Reduction and Statistical Analysis

To analyze the EMG data, each continuous file was first visually inspected for noise and artifacts using ANSLAB (Wilhelm & Peyk, 2005). During EMG data acquisition, facial movements such as yawning were marked and subsequently excluded. EMG data were used to calculate facial responses to stimuli. The prestimulus window was 500 ms before the onset of the pictures; poststimulus muscle activity was averaged in 500-ms bins. The prestimulus value was subtracted from the poststimulus values to calculate facial reactivity as change from baseline. Values were standardized within participants and within muscles in order to allow meaningful comparisons across muscles and participants. Finally, we computed mean levels of activity for each muscle and each type of emotion. For statistical analyses, the first 2

s poststimulus were dropped because in the dynamic facial stimuli, emotional expression was too subtle to be detectable and visual data inspection showed only minimal EMG effects. To evaluate mimicry effects, data were analyzed with a 2 (Group: HSA vs. LSA) \times 2 (Emotion: target emotion vs. neutral face) \times 10 (Time: from Second 2 of the stimuli presentation to the end in 500-ms bins) repeated-measures analysis of variance (ANOVA) for each emotion (cf. Moody et al., 2007). To ensure that participants did not react to the neutral stimuli in a specific way, we first calculated a 2 (Group: HSA vs. LSA) \times 4 (Muscle: *m. corrugator supercilii*, *m. frontalis medialis*, *m. levator labii*, *m. zygomaticus major*) \times 10 (Time: from Second 2 of the stimulus presentations to the end in 500-ms bins) repeated-measures ANOVA only for neutral stimuli. If the assumption of sphericity was violated, Greenhouse–Geisser correction was used. For additional correlational analyses, we calculated a mimicry index for every emotion using the mean values for every target emotion minus the mean values for the neutral emotion.

Results

Emotional Mimicry

As expected, the ANOVA for the reaction to neutral faces (Group \times Muscle \times Time) yielded no significant interaction effects of Muscle \times Time \times Group, $F(9.60, 355.31) = .63, p = .78, \eta^2 = .02$, Muscle \times Time, $F(9.60, 355.31) = .88, p = .55, \eta^2 = .02$, Time \times Group, $F(3.92, 144.95) = 1.25, p = .29, \eta^2 = .03$, or Muscle \times Group, $F(2.04, 75.51) = 2.04, p = .14, \eta^2 = .05$, and no significant main effects of time, $F(3.92, 144.95) = 1.25, p = .29, \eta^2 = .03$, or group, $F(1, 37) = 1.13, p = .29, \eta^2 = .03$. However, there was a significant main effect of muscle, $F(2.04, 75.51) = 3.74, p = .03, \eta^2 = .09$. Whereas the *m. corrugator supercilii* and *m. frontalis medialis* indicated a slight activation in response to the neutral stimuli, the *m. zygomaticus major* and *m. levator labii* showed a slight deactivation.

Anger (*m. corrugator supercilii*). The mean data for the *m. corrugator supercilii* in response to angry expressions are presented in Figure 1. Angry faces as compared to neutral faces tended to evoke greater *m. corrugator supercilii* activity over time, indicated by an Emotion \times Time interaction effect, $F(3.46, 131.41) = 3.97, p < .01, \eta^2 = .10$, and confirming the emotional mimicry effect. However, none of the other effects reached significance: Group \times Emotion \times Time, $F(3.46, 131.41) = 1.67, p = .17, \eta^2 = .04$; Group \times Time, $F(2.55, 97.07) = 0.61, p = .59, \eta^2 = .02$; Group \times Emotion, $F(1, 38) = 0.85, p = .36, \eta^2 = .02$; emotion, $F(1, 38) = 0.20, p = .66, \eta^2 = .01$, and group, $F(1,38) = 0.01, p = .92, \eta^2 = .00$.

Anxiety (*m. frontalis medialis*). As visible in Figure 1, anxious faces as compared to neutral faces evoked greater *m. frontalis medialis* activity over time, indicated by an Emotion \times Time interaction effect, $F(3.65, 138.59) = 8.04, p < .01, \eta^2 = .18$. The main effect of emotion, $F(1,38) = 11.45, p < .01, \eta^2 = .13$, indicated that *m. frontalis medialis* activity was higher for anxiety than for neutral stimuli, and the main effect of time, $F(3, 113.85) = 2.94, p = .04, \eta^2 = .07$, indicated an increase over time. However, none of the other effects reached significance: Group \times Emotion \times Time, $F(3.65, 138.59) = 1.05, p = .38, \eta^2 = .03$; Group \times Time, $F(3, 113.85) = 2.09, p = .11, \eta^2 = .05$; Group \times Emotion, $F(1, 38) = 1.24, p = .27, \eta^2 = .05$; and group, $F(1,38) = 0.09, p = .77, \eta^2 = .00$.

Sadness (*m. frontalis medialis*). The mimicry effect was shown by a significant Emotion \times Time interaction effect, $F(2.55, 96.71) = 9.53, p < .01, \eta^2 = .20$, and significant main effects of emotion, $F(1,38) = 7.12, p = .01, \eta^2 = .16$, and time, $F(2.31, 87.64) = 4.80, p = .01, \eta^2 = .11$ (Figure 1). None of the other effects reached significance: Group \times Emotion \times Time, $F(2.55, 96.71) = 1.16, p = .33, \eta^2 = .03$; Group \times Time, $F(2.31, 87.64) = 0.71, p = .51, \eta^2 = .02$; Emotion \times Group, $F(1, 38) = 1.96, p = .17, \eta^2 = .05$; and group, $F(1,38) = 0.23, p = .63, \eta^2 = .01$.

Disgust (*m. levator labii*). There was a significant Emotion \times Time interaction effect, $F(2.43, 89.80) = 7.36, p < .01, \eta^2 = .17$, indicating a greater increase in *m. levator labii* activity for disgust stimuli than for neutral stimuli (Figure 2). The main effect of time was significant, $F(3.04, 92.92) = 5.69, p < .01, \eta^2 = .13$, indicating an overall increase in *m. levator labii* activity over time. The main effect of emotion was just nonsignificant, $F(1,37) = 3.97, p = .054, \eta^2 = .10$, and the *m. levator labii* activation for disgust was higher than for the neutral emotion (Figure 2). Furthermore, there was a significant main effect of group, $F(1, 37) = 10.46, p < .01, \eta^2 = .22$, indicating that HSA participants reacted with a higher *m. levator labii* activation not only to disgust faces, indicating a stronger mimicry, but also to neutral faces. There was no significant effect of Emotion \times Group, $F(1, 37) = .08, p = .78, \eta^2 = .00$; Time \times Group, $F(2.51, 92.92) = 1.02, p = .38, \eta^2 = .03$; or Emotion \times Time \times Group, $F(2.43, 89.80) = 0.83, p = .46, \eta^2 = .02$.

Happiness (*m. zygomaticus major*). Happy as compared to neutral faces tended to evoke overall greater *m. zygomaticus major* activity, indicated by a strong emotion main effect, $F(1, 37) = 18.29, p < .01, \eta^2 = .33$ (Figure 2). There was also an Emotion \times Time interaction effect, indicating that the difference in activation between happy faces and neutral faces increased over time, $F(2.27, 83.85) = 3.51, p = .03, \eta^2 = .09$. None of the other effects reached significance: Group \times Emotion \times Time, $F(2.27, 83.85) = 1.35, p = .27, \eta^2 = .04$; Group \times Time, $F(2.15, 79.50) = 0.54, p = .60, \eta^2 = .01$; Group \times Emotion, $F(1, 37) = 0.30, p = .59, \eta^2 = .01$; time, $F(2.15, 79.50) = 1.80, p = .17, \eta^2 = .05$, and group, $F(1, 37) < 0.01, p = .97, \eta^2 = .00$.

Emotion Recognition

As reported in Table 2, participants decoded over 95% of the happy and neutral faces correctly. These two conditions were excluded from the analyses of group differences because of ceiling effects. The ANOVA for the percentage of correct responses with the within-

subject factor emotion and the between-subjects factor group showed no significant Emotion \times Group interaction effect, $F(3, 117) = 0.32, p = .79, \eta^2 = .01$. There was a main effect of emotion, $F(3, 117) = 9.37, p < .01, \eta^2 = .19$, indicating that participants made more errors identifying anxiety and disgust than identifying anger and sadness. The main effect of group just failed to reach significance, $F(1, 39) = 3.51, p = .07, \eta^2 = .08$, with HSA participants showing a tendency toward a reduced recognition of facial expressions in general.

Self-Reported Emotion Regulation

As shown in Table 3, the one-way ANOVAs yielded significant group differences for difficulties in emotion regulation (DERS), reflecting more self-reported difficulties in HSA than LSA participants, $F(1, 39) = 13.19, p < .01, \eta^2 = .25$, as well as in its subscales nonacceptance, $F(1, 39) = 10.63, p < .01, \eta^2 = .21$; impulse control difficulties, $F(1, 39) = 11.10, p < .01, \eta^2 = .22$; lack of strategies, $F(1, 39) = 13.55, p < .01, \eta^2 = .26$; and lack of emotional clarity, $F(1, 39) = 10.36, p < .01, \eta^2 = .21$. There were no significant group differences in the DERS subscales goal attainment problems, $F(1, 39) = 1.90, p = .18, \eta^2 = .05$, or lack of awareness, $F(1, 39) = .02, p = .89, \eta^2 < .01$.

Mood

The 2 (Group: HSA vs. LSA) \times 2 (Time: before and after mimicry paradigm) \times 6 (Emotional state: anxiety, happiness, sadness, anger, excitement, and arousal) repeated-measures ANOVA revealed no significant interaction effect of Group \times Time \times Emotional state, $F(3.83, 149.49) = 0.67, p = .61, \eta^2 = .02$, Group \times Time, $F(1, 39) < 0.01, p > .99, \eta^2 < .01$, or Time \times Emotional state, $F(3.83, 149.49) = 2.28, p = .07, \eta^2 = .06$. However, there was a significant interaction effect of Group \times Emotional state, $F(3.02, 117.57) = 4.41, p < .01, \eta^2 = .10$, with HSA participants experiencing more negative (excitement, arousal, sadness, anger) and less positive (happiness) emotions than LSA participants before and after the

experiment. There was also a significant main effect of Group, $F(1,39) = 4.04, p = .05, \eta^2 = .09$, with HSA participants achieving higher values than LSA participants. Bonferroni-corrected post hoc comparisons indicated group main effects of excitement (HSA: $M = 2.76, SD = 1.07$; LSA $M = 2.00, SD = 0.73$), $F(1,39) = 7.07, p = .01, \eta^2 = .15$, and arousal (HSA: $M = 3.12, SD = 1.27$; LSA: $M = 2.03, SD = 0.79$), $F(1,39) = 10.82, p < .01, \eta^2 = .22$, with HSA participants achieving higher values than LSA participants. Therefore, we calculated correlations of arousal and excitement with all outcome measures. All correlations between emotional mimicry and emotional state were nonsignificant; correlation coefficients ranged between $r = -.07$ and $r = .03$ for excitement and between $r = -.19$ and $r = .02$ for arousal. There was no correlation of emotion recognition with excitement ($r = -.05, p = .76$) or with arousal ($r = -.14, p = .37$).

Additional Correlational Analyses

Emotion regulation difficulties (DERS total score) were negatively associated with the mimicry of anxiety, $r = -.37, p = .02$. There were no other significant correlations between emotional mimicry and emotion regulation difficulties. Overall emotion recognition performance was positively correlated with mimicry of anxiety, $r = .32, p = .04$. However, none of the other emotional mimicry effects correlated with emotion recognition. There was no significant association between emotion regulation and emotion recognition, $r = -.20, p = .22$.

Discussion

The aim of the present study was to investigate if social anxiety is related to emotional mimicry, emotion recognition, and self-reported emotion regulation difficulties. The results indicate that HSA individuals show subtle differences in emotional mimicry compared to LSA individuals. In addition, a tendency toward poorer emotion recognition ability

characterized HSA participants, who endorsed more self-reported emotion regulation difficulties across different emotion regulation domains.

To our knowledge, this is the first study examining emotional mimicry with an experimental paradigm in individuals with social anxiety. So far this topic has been investigated only in public speaking anxiety (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004). Importantly, we replicated the general emotional mimicry effect for each tested emotion and not only for the well-evaluated emotions happiness and anger, with their corresponding muscles *m. zygomaticus major* and *m. corrugator supercilii* (Hess & Fischer, 2013). In addition, we confirmed the emotional mimicry effect also for the less often investigated emotions anxiety (Moody et al., 2007) and sadness (Cram & Criswel, 2010), both indexed by *m. frontalis medialis* activity, as well as for disgust with *m. levator labii* activity (Lundqvist & Dimberg, 1995). The emotional mimicry effect was indicated by either a significant interaction effect (EMG activity for the target emotion increased, whereas there was no change for the neutral emotion) or a significant main effect of emotion, with a higher activity for the target emotion than for the neutral emotion. The successful replication and extension of emotional mimicry effects confirm the validity of the novel set of dynamic color stimuli and support the utility of dynamic images because of their power to elicit particularly large mimicry effects (Sato et al., 2008).

The emotional mimicry effect for each emotion was generally shown in both groups, providing the basis for successful social interactions by fostering affiliation and liking (Lakin et al., 2003). Nevertheless, even small differences in emotional mimicry could lead to difficulties in social interactions. Therefore, examining group comparisons in detail is of special interest. HSA participants reacted to disgusted and neutral faces with higher *m. levator labii* activation. This is comparable with the results from Vrana and Gross (2004) indicating more *m. corrugator supercilii* activity as a reaction to neutral faces in people high in fear of

public speaking. Both reactions can be interpreted as negative emotional facial expressions. The stronger mimicry reaction to disgust is of special importance. The more beneficial influence of positive emotional mimicry on social interactions compared to the mimicry of negative emotions has already been highlighted (Hess et al., 2000; Knutson, 1996). Furthermore, disgust can be interpreted as a sign of disapproval (Heuer, Lange, Isaac, Rinck, & Becker, 2010). It should be further investigated if the stronger mimicry of disgust leads to the perception of HSA individuals as less likeable, sympathetic, or talkative (Alden & Wallace, 1995). On the other hand, there were no group differences for the emotional mimicry of happiness, sadness, anger, and or anxiety. Our results differ from results of studies that compared people with different levels of fear of public speaking. People high in fear of public speaking showed less mimicry of happy expressions (Dimberg, 1997; Dimberg & Christmanson, 1991; Dimberg & Thunberg, 2007; Vrana & Gross, 2004) and either less (Dimberg & Christmanson, 1991) or more (Dimberg, 1997; Dimberg & Thunberg, 2007; Vrana & Gross, 2004) mimicry of anger. However, these results are based on static facial expressions that might be more limited in ecological validity than the dynamic expressions used in our study.

In the current study, better emotion recognition was associated with more mimicry of anxiety, but not of other emotions. It remains an open question if emotional mimicry facilitates emotion recognition, as suggested by Niedenthal et al. (2010). Regarding group differences, only a tendency ($p = .07$) toward worse emotion recognition of negative facial expression in HSA compared to LSA participants emerged in our study. This is in line with previous studies where recognition accuracy did not differ between socially anxious participants and healthy controls (Arrais et al., 2010; Bell et al., 2011; Campbell et al., 2009; Joormann & Gotlib, 2006; Leber et al., 2009; Philippot & Douilliez, 2005; Stevens et al., 2008), but it is in contrast to an enhanced recognition of all facial expressions (Hunter et al., 2009) and of negative expressions (Foa et al., 2000; Lundh & Ost, 1996; Winton et al., 1995)

in HSA compared to LSA individuals. In our study, the overall recognition accuracy was high and we had to exclude the conditions happiness and neutral from analyses because of ceiling effects. To avoid ceiling effects, future studies might include more positive emotions and a dynamic presentation of the neutral condition, for example, with opening and closing the mouth.

We had an equal sex distribution across groups, but in both groups more women participated. This could have influenced the recognition accuracy since women have been shown to be better in emotion recognition than men (Hall & Matsumoto, 2004). Whereas most of the studies done so far used black-and-white static stimuli (Arrais et al., 2010; Campbell et al., 2009; Joormann & Gotlib, 2006; Leber et al., 2009; Philippot & Douilliez, 2005; Winton et al., 1995), we used gradually changing dynamic color pictures in order to more closely simulate dynamic facial expressions as they might occur in daily life, to raise ecological validity. The two previous mimicry studies using dynamic facial expressions (Bell et al., 2011; Joormann & Gotlib, 2006) used morphing presentation times longer than 25 s that may have appeared to be too slow and thus unnatural to participants. This may explain some of the divergent findings between their studies and ours.

Previous studies did not control for mood, despite its effect on emotion recognition (Mullins & Duke, 2004) and emotional mimicry (Moody et al., 2007). In our study, a neutral mood was induced with a documentary film. Nevertheless, after mood induction HSA participants still indicated that they experienced a higher amount of excitement and arousal than LSA participants. However, correlational analyses indicated no systematic effect of these emotional states on mimicry and recognition performance. It is well known that participants with high anxiety-related traits react more anxiously to novel laboratory environments with an unknown experimenter. This constitutes a particular challenge in emotion research that might

require the use of ambulatory assessment technologies to be circumvented (Wilhelm & Grossman, 2010).

Regarding emotion regulation difficulties, HSA participants reported having more trouble accepting their feelings and having limited access to emotion regulation strategies. These questionnaire findings are in line with results of previous studies (Mennin et al., 2009; Rusch et al., 2012) and together with the altered emotional mimicry suggest that including emotion regulation training that addresses socioemotional mimicry in cognitive-behavioral treatment of social anxiety may be beneficial to patients. As in the Rusch et al. (2012) study, HSA participants reported more impulse control difficulties. Experiencing uncontrollable anxiety might enhance the impression of having no control over the situation as a whole (Rusch et al., 2012). Unlike in previous studies using the same questionnaire (Mennin et al., 2009; Rusch et al., 2012), HSA participants in our study also reported a lack of emotional clarity, indicating confusion caused by emotions. However, we found no association between emotion regulation and emotion recognition in others. Further, emotion regulation difficulties were associated with less mimicry of anxiety, but not with other emotions.

Several limitations of the current study have to be considered. First, our study has a limited generalizability, since the sample consisted of a subclinical socially anxious group. However, since eight HSA individuals were above an accepted clinical cut-off score for social anxiety on the SPS (according to Heinrichs et al., 2002), it is likely that some of the results generalize to clinical samples. Stopa and Clark (2001) indicated that the results from analogue studies are typically similar to those of clinical studies. Due to the high comorbidity of SAD, for example, with depressive disorders, it will be important to describe the influence of different comorbid disorders on the capacity to recognize and regulate emotions. Second, in daily life, emotional expressions usually occur in social contexts, which could influence mimicry of these expressions and recognition ability. Therefore, more natural laboratory

study designs are needed. Measuring mimicry during a conversation with a stranger may be a promising approach. And third, the relatively small sample size could be responsible for some nonsignificant findings.

Results of the present study offer new ways to understand the underlying factors and mechanisms of social anxiety. The observed enhanced mimicry of disgust in HSA participants could be misinterpreted as disapproval and rejection of the conversational partner (Heuer et al., 2010). Most likely, the conversational partner will react to this rejection by expressing rejection. This could result in a vicious circle and constitute a self-fulfilling prophecy that contributes to the maintenance of social anxiety. Therefore, our results also suggest approaches for treatment. Recently, new techniques for supporting patients as they learn to access and handle their emotions were implemented. For example, acceptance and commitment therapy (ACT) has its main focus on helping patients accept their feelings. It had been shown to be effective in several anxiety disorders (Arch et al., 2012) and seems promising for the treatment of SAD. It may help HSA individuals clarify emotions they feel and deal with difficulties accepting their emotions. It remains to be seen if it is helpful to add emotion recognition and expression training to existing treatments.

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Contributors

CR contributed ideas to the paper, drafted and revised the manuscript, and performed psychophysiological and statistical analyses. TI and MS contributed ideas to the paper and

drafted and revised the manuscript. UK performed psychophysiological data analysis, provided support for the collection of psychophysiological data and revised the manuscript. FW provided support for the collection and analyses of psychophysiological data and revised the manuscript. All authors read and approved the final manuscript.

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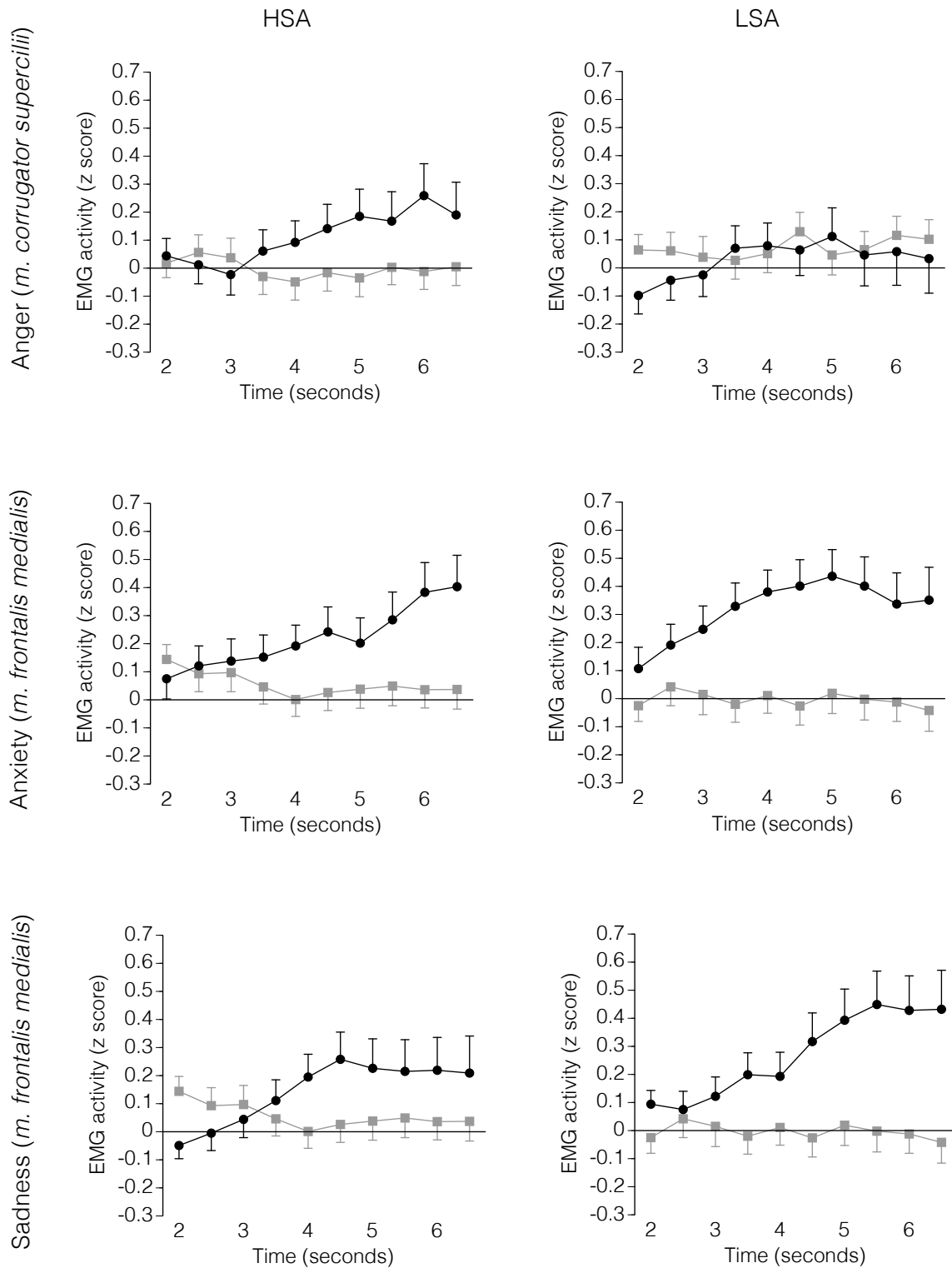
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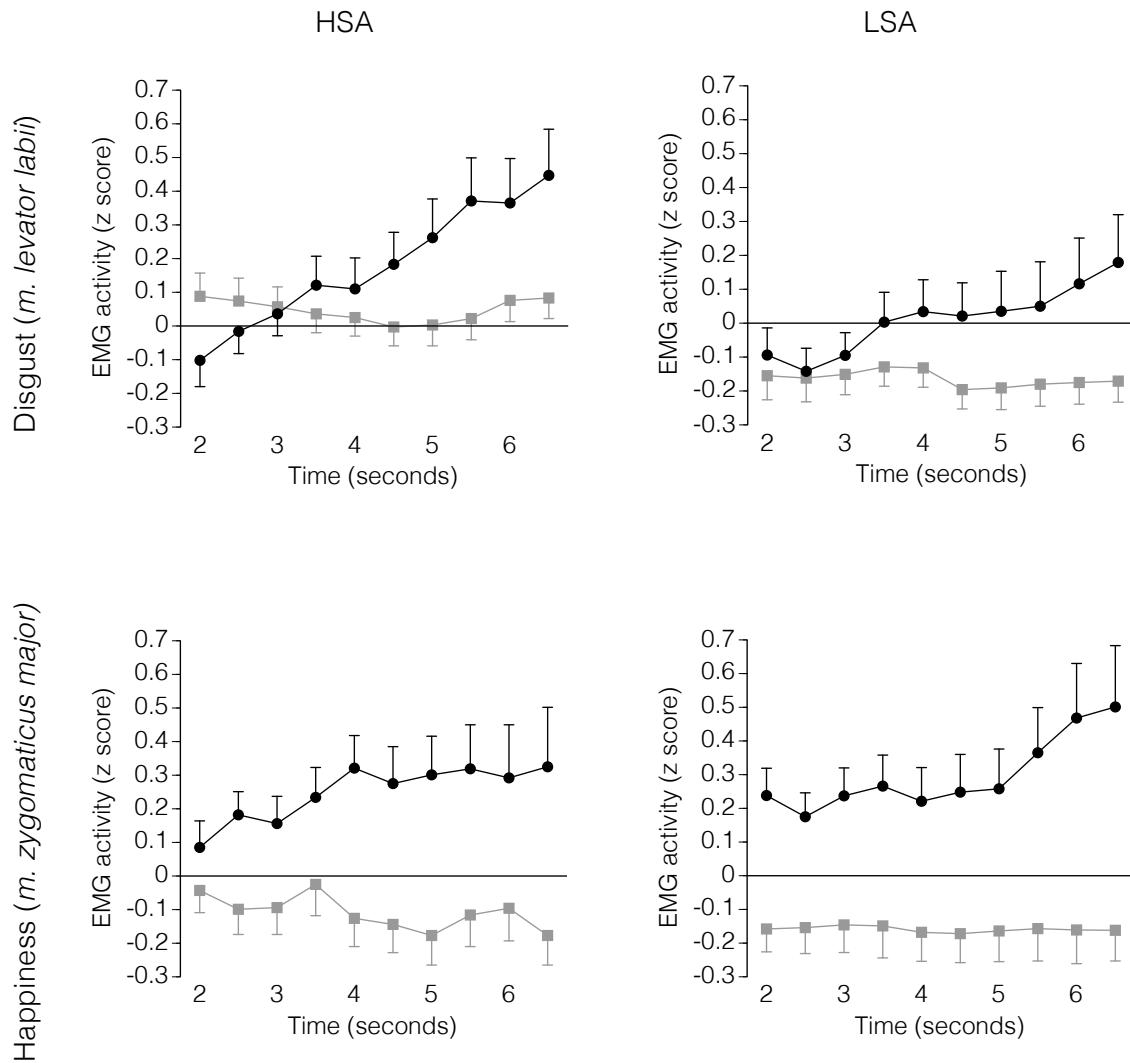
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Figure 1. Average facial electromyography (EMG) activity in emotion-specific channels over 500-ms intervals during Seconds 2–7 for high socially anxious (HSA) and low socially anxious (LSA) groups: reactions to dynamic facial expression stimuli depicting anger, anxiety, and sadness.



Note. Gray line = neutral, black line = target emotion.

Figure 2. Average facial electromyography EMG activity in emotion-specific channels over 500-ms intervals during Seconds 2–7 for high socially anxious (HSA) and low socially anxious (LSA) groups: reactions to dynamic facial expression stimuli depicting disgust and happiness.



Note. Gray line = neutral, black line = target emotion.

Table 1

Clinical Correlates of Low Socially Anxious (LSA) and High Socially Anxious (HSA)

Participants, as Well as Mann–Whitney U-Test Results

Measure	LSA	HSA	<i>U</i>
	<i>M (SD)</i>	<i>M (SD)</i>	
SIAS	11.15 (5.01)	26.67 (10.61)	390**
SPS	3.55 (2.06)	17.71 (9.80)	392**
LSAS	8.00 (2.25)	54.62 (13.18)	420**

Note. SIAS = Social Interactions Anxiety Scale, SPS = Social Phobia Scale, LSAS = Liebowitz Social Phobia Scale. ** $p < .01$.

Table 2

Mean Percentage (Standard Deviation) of Emotion Recognition for Low Socially Anxious (LSA) and High Socially Anxious (HSA) Participants, as Well as Exploratory t-Test Results Comparing the Emotion Recognition Performance for Each Emotion Separately Between HSA and LSA

Emotion	LSA, $n = 20$ $M (SD)$	HSA, $n = 21$ $M (SD)$	$t (39)$	p
Anger	93.00% (8.01%)	90.95% (9.95%)	0.72	0.47
Anxiety	84.00% (13.92%)	77.62% (17.58%)	1.28	0.21
Disgust	81.00% (11.19%)	79.52% (12.44%)	0.40	0.69
Sadness	91.50% (8.12%)	87.62% (14.11%)	1.09	0.29
Neutral	94.50% (9.45%)	97.62% (6.25%)	-1.25	0.22
Happiness	100% (0%)	99.52% (2.18%)	0.98	0.34

Table 3

Means (SD) and Group Comparisons of Self-Reported Emotion Regulation Facets Assessed With the Difficulties in Emotion Regulation Scale (DERS; Ehring et al., 2010; Gratz & Roemer, 2004)

DERS	Group		<i>F</i> (1, 39)
	LSA ^a	HSA ^b	
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	
Nonacceptance	9.07 (2.96)	12.90 (3.32)	10.63**
Goals	13.26 (4.28)	15.14 (4.45)	1.89
Impulse	8.80 (2.65)	12.10 (3.60)	11.10*
Awareness	13.55 (3.71)	13.71 (4.14)	0.02
Strategies	13.70 (4.14)	19.50 (5.73)	13.55**
Clarity	7.70 (1.63)	10.38 (3.36)	10.36**
Total	66.70 (13.69)	83.71 (16.14)	13.19**

Note. LSA = Low socially anxious; HSA = high socially anxious.

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

Research Article

Proposed Diagnostic Criteria for the *DSM-5* of Nonsuicidal Self-Injury in Female Adolescents: Diagnostic and Clinical Correlates

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Nonsuicidal self-injury (NSSI) is included as conditions for further study in the *DSM-5*. Therefore, it is necessary to investigate the proposed diagnostic criteria and the diagnostic and clinical correlates for the validity of a diagnostic entity. The authors investigated the characteristics of NSSI disorder and the proposed diagnostic criteria. A sample of 73 female inpatient adolescents and 37 nonclinical adolescents (aged 13 to 19 years) was recruited. Patients were classified into 4 groups (adolescents with NSSI disorder, adolescents with NSSI without impairment/distress, clinical controls without NSSI, and nonclinical controls). Adolescents were compared on self-reported psychopathology and diagnostic cooccurrences. Results indicate that adolescents with NSSI disorder have a higher level of impairment than adolescents with other mental disorders without NSSI. Most common comorbid diagnoses were major depression, social phobia, and PTSD. There was some overlap of adolescents with NSSI disorder and suicidal behaviour and borderline personality disorder, but there were also important differences. Results further suggest that the proposed *DSM-5* diagnostic criteria for NSSI are useful and necessary. In conclusion, NSSI is a highly impairing disorder characterized by high comorbidity with various disorders, providing further evidence that NSSI should be a distinct diagnostic entity.

1. Introduction

Given the prevalence of nonsuicidal self-injury (NSSI) [1, 2], its related problems [3, 4], and the findings that it is often present in individuals who are not diagnosed with borderline personality disorder (BPD) [5], NSSI should be considered a distinct diagnostic category. Currently, NSSI is not in the classification system of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* or the *International Classification of Diseases, tenth revision (ICD-10)* as a distinct entity, but it does exist as a symptom of BPD. So far, several attempts have been undertaken to include an NSSI disorder in the DSM [6, 7], the most recent for the upcoming fifth edition, the *DSM-5* [8]. For the *DSM-5* NSSI is included as conditions for further study, indicating that criteria sets will need further research before it will be

an official diagnosis [9]. The most important justification is clearly the clinical benefit that a distinct diagnosis for NSSI leads to a better understanding, management, and specific treatment. Previously, Muehlenkamp [6] proposed more generally that repetitive NSSI should be established as a diagnostic entity to improve research on this behavior. More recently, Wilkinson and Goodyer [10] proposed in addition to the clinical benefit several positive consequences if NSSI were to be classified as a diagnosis in its own right, such as improving communication between professionals and patients and increasing research into the nature, course, and outcome of NSSI. In addition a diagnosis is also the base to provide financing from health insurances. Currently many patients with NSSI are officially diagnosed with their comorbid diagnoses or with BPD even without fulfilling all required criteria, although, NSSI is their main problem

and therefore the main goal of psychotherapy should focus on NSSI. However, without an official diagnosis there is a discrepancy and intransparency between communication to the patient and the health insurance companies. As there is now a definition for NSSI and suggested diagnostic criteria for the *DSM-5*, it is necessary to test these criteria and to have diagnostic and clinical correlates.

In a recent adolescent community study [11] the prevalence rate of NSSI using the proposed criteria for *DSM-5* was 6.7%. However, regarding criterion D it was not assessed whether adolescents self-injured during states of psychosis nor whether they engaged in NSSI when not intoxicated [11]. Data from clinical samples are to our knowledge not available.

One important aspect of a new distinct entity that is also relevant for diagnostic validity is its delimitation in respect to other disorders [12]. Regarding NSSI, a clear differentiation from BPD is needed. Self-injurious behavior is one of nine symptoms of BPD in the *DSM-IV-TR*. However, although NSSI and BPD can cooccur, they also occur independently. Even early reports warned against subsuming NSSI under a specific personality disorder. Several studies indicated that only about 50% of those who engage in NSSI suffer from BPD [5, 13, 14]. These studies had the limitation that at the time of their investigations, diagnostic criteria for NSSI were not yet available, and thus they used different definitions of NSSI that are not comparable, such as that NSSI has to be engaged in repeatedly (on 5 or more days in the last year). In a retrospective chart review, Selby et al. [15] compared treatment-seeking adult outpatients who engaged in NSSI with a group with BPD as well as a comparison group with various Axis I diagnoses. The NSSI and BPD groups had similar levels of impairment and psychopathology. The NSSI group was characterized by higher depressive symptoms, anxiety, and suicidality than the clinical comparison group. However, most of the NSSI group did not exhibit subthreshold BPD symptoms. As the data were obtained from the charts, no information was available about frequency and motivation for NSSI. Nevertheless, results indicated that NSSI has the potential to be a separate diagnostic entity.

Another important yet difficult distinction has to be made between NSSI and attempted suicide. Three key differences are noteworthy. First, most people engaging in NSSI have, per definition, no intent to die during the self-injuring act. Second, methods and injuries of NSSI are often less severe and usually the damage is not life threatening. Third, NSSI and suicide differ in the frequency of the act, as NSSI often occurs daily [16, 17]. Nevertheless, it is important to highlight that longitudinal studies show that NSSI is a significant predictor for suicidal behavior and most people engaging in NSSI report suicidal ideation [18–20].

The issue of an unclear definition of NSSI also applies for studies investigating methods of NSSI and diagnostic and clinical correlates. Nock et al. [13] and Hintikka et al. [21] investigated diagnostic correlates in adolescents with NSSI. The most common Axis I disorders in adolescents with NSSI were major depressive disorder, conduct disorder, and PTSD [13, 21]. In the study by Nock et al. [13], 67.3% of the sample met criteria for a *DSM-IV* personality disorder, of which BPD was most common (51.7%). Regarding methods

and characteristics of NSSI, Nixon et al. [22] investigated 42 hospitalized adolescents with repetitive NSSI. All endorsed cutting and/or scratching. More than 80% reported almost daily urges to self-injure, and more than 60% reported at least once-a-week acts of self-injury. Seventy-four percent of the adolescents reported having attempted suicide at least once in the past 6 months. Axis II disorders or symptoms of BPD were not assessed in the Nixon et al. [22] study, nor impairment or distress due to NSSI. Clinical correlates indicate that patients with NSSI have difficulties in emotion regulation [23] and, as found in studies of diagnostic correlates, elevated depression as well as externalizing and borderline symptomatology [15, 24, 25].

As yet, there have been precious few empirical studies investigating diagnostic and clinical correlates using the proposed *DSM-5* criteria for NSSI and therefore little data support the validity of the criteria. Thus, our aim was threefold: first, to investigate the proposed diagnostic criteria for NSSI for the *DSM-5* using a clinical interview with inpatient female adolescents; second, to examine the diagnostic and clinical correlates of adolescents with NSSI disorder; and third, to compare adolescents with NSSI disorder with adolescents with no mental disorders, adolescents with mental disorders without NSSI, and subgroups of adolescents with NSSI such as adolescents with NSSI who did not report impairment or distress. We hypothesized that adolescents with NSSI disorder can be differentiated from other clinical and nonclinical groups. That adolescents with NSSI disorder would be more likely to have a history of suicide attempts, would have more comorbid diagnoses and score higher on self-reported psychopathology, especially borderline symptoms, and would have difficulties in emotion regulation and be more impaired in global functioning compared with the other groups.

2. Method

2.1. Participants. Participants were 110 female adolescents, aged 13–18 years, recruited from different inpatient psychiatric units in Switzerland and Germany. Participants included 41 adolescents who fulfilled the proposed *DSM-5* criteria for NSSI disorder, 12 adolescents with NSSI but denied being impaired or distressed due to NSSI, 20 adolescents with a *DSM-IV* diagnosis other than NSSI, and 37 nonclinical adolescents who had no current or past experience of mental disorder. Adolescents with repetitive NSSI but who denied being impaired or distressed due to NSSI were the only subgroup in the NSSI group that could be used for further analyses. These adolescents indicated in the diagnostic interview repetitive NSSI but denied the questions on impairment and distress in different settings such as family, school, or leisure. In addition they denied questions such as if the patient has to hide the wounds and scars in daily life, if the patient thinks about possible long term consequences of the behavior, and how difficult it would be to stop from one day to the other with NSSI. Demographic and psychosocial characteristics of adolescents with NSSI disorder, adolescents with NSSI without impairment/distress, clinical controls, and nonclinical controls are reported in Table 1. The samples were

TABLE 1: Demographic and psychosocial characteristics of adolescents with NSSI disorder (NSSI), compared with non-clinical adolescents (NCA), clinical controls without NSSI (CCA), and adolescents with NSSI without impairment/distress (NSSI-C).

Characteristic	NCA (<i>n</i> = 37)	CCA (<i>n</i> = 20)	NSSI-C (<i>n</i> = 11)	NSSI disorder (<i>n</i> = 39)	Welch's <i>F</i> (3, 33.36)
Mean age (SD) in years	14.60 (1.02)	15.93 (1.52)	17.08 (1.92)	15.94 (1.42)	12.19** <i>F</i> (3, 79)
Mean no. of school years (SD)	8.40 (1.08)	9.25 (1.58)	9.33 (1.41)	9.16 (1.10)	2.88*
Number (percentage) living with parents ^a	31 (100)	15 (93.8) ^a	11 (100)	26 (83.9) ^b	χ^2 (9) = 10.2
Number (percentage) whose parents have joint custody ^c	31 (86.1)	12 (75.0)	7 (70.0)	20 (66.7)	χ^2 (9) = 8.04

Note. * $p < .05$, ** $p < .01$. ^aOne was in another child and adolescent psychiatric clinic ^bthree children lived in a supervised residential group, one in a foster family, and one in another child and adolescent psychiatric clinic, ^cthe rest had mothers with sole custody.

different with respect to age ($F = 6.14$, $p < .01$). Post hoc analysis indicated that this effect was mainly due to the younger age of the nonclinical adolescents group.

2.2. Procedure. All participants and their parents were informed about the study and gave their written consent in accordance with the Declaration of Helsinki. The local ethics committee approved the study.

2.3. Measures: Assessment of Axis I and Axis II Diagnoses. To examine the participants' current or past *DSM-IV-TR* diagnoses for Axis I disorders, we conducted a structured interview with each adolescent. The *Diagnostic Interview for Mental Disorders in Children and Adolescents* [45, Kinder-DIPS] assesses the most frequent mental disorders in childhood and adolescence (all anxiety disorders, depression, ADHD, conduct disorder, sleep disorders, and eating disorders) and includes substance use disorders and borderline personality disorder from the adult DIPS [26]. The Kinder-DIPS has good validity and reliability for Axis I disorders (child version, $\kappa = 0.48$ – 0.88) [27]. NSSI was assessed using the proposed *DSM-5* criteria (proposed criteria in 2012). The proposed criteria as of 2012 and the final published version are comparable as follows.

Proposed diagnostic criteria for nonsuicidal self-injury (NSSI) for the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (As of November 2012, <http://www.dsm5.org/>) used for the present study.

- (A) In the last year, the individual has, on 5 or more days, engaged in intentional self-inflicted damage to the surface of his or her body, of a sort likely to induce bleeding or bruising or pain (e.g., cutting, burning, stabbing, hitting, and excessive rubbing), for purposes not socially sanctioned (e.g., body piercing, tattooing, etc.), but performed with the expectation that the injury will lead to only minor or moderate physical harm. The behavior is not a common one, such as picking at a scab or nail biting.
- (B) The intentional injury is associated with at least 2 of the following:

- (1) psychological precipitant: interpersonal difficulties or negative feelings or thoughts, such as depression, anxiety, tension, anger, generalized distress, or self-criticism, occurring in the

period immediately prior to the self-injurious act,

- (2) urge: prior to engaging in the act, a period of preoccupation with the intended behavior that is difficult to resist,
- (3) preoccupation: thinking about self-injury occurs frequently, even when it is not acted upon,
- (4) contingent response: the activity is engaged in with the expectation that it will relieve an interpersonal difficulty, negative feeling, or cognitive state, or that it will induce a positive feeling state, during the act or shortly afterwards.

- (C) The behavior or its consequences cause clinically significant distress or interference in interpersonal, academic, or other important areas of functioning. (This criterion is subject to final approval on the use of criteria that relate symptoms to impairment.)
- (D) The behavior does not occur exclusively during states of psychosis, delirium, or intoxication. In individuals with a developmental disorder, the behavior is not part of a pattern of repetitive stereotypies. The behavior cannot be accounted for by another mental or medical disorder (i.e., psychotic disorder, pervasive developmental disorder, mental retardation, Lesch-Nyhan syndrome, stereotyped movement disorder with self-injury, or trichotillomania).
- (E) The absence of suicidal intent has either been stated by the patient or can be inferred by repeated engagement in a behavior that the individual knows, or has learnt, is not likely to result in death.

Diagnostic criteria for NSSI according to *DSM-5* [9] are as follows:

- (A) In the last year, the individual has, on 5 or more days, engaged in intentional self-inflicted damage to the surface of his or her body of a sort likely to induce bleeding, bruising, or pain (e.g., cutting, burning, stabbing, hitting, and excessive rubbing), with the expectation that the injury will lead to only minor or moderate physical harm (i.e., there is no suicidal intent).

Note: The absence of suicidal intent has either been stated by the individual or can be inferred by

the individual's repeated engagement in a behavior that the individual knows, or has learned, is not likely to result in death.

- (B) The individual engages in the self-injurious behavior with one or more of the following expectations:
- (1) to obtain relief from a negative feeling or cognitive state,
 - (2) to resolve an interpersonal difficulty,
 - (3) to induce a positive feeling state.
- Note: The desired relief or response is experienced during or shortly after the self-injury, and the individual may display patterns of behavior suggesting a dependence on repeatedly engaging in it.
- (C) The intentional self-injury is associated with at least one of the following:
- (1) interpersonal difficulties or negative feelings or thoughts, such as depression, anxiety, tension, anger, generalized distress, or self-criticism, occurring in the period immediately prior to the self-injurious act,
 - (2) prior to engaging in the act, a period of pre-occupation with the intended behavior that is difficult to control,
 - (3) thinking about self-injury that occurs frequently, even when it is not acted upon.
- (D) The behavior is not socially sanctioned (e.g., body piercing, tattooing, part of a religious or cultural ritual) and is not restricted to picking a scab or nail biting.
- (E) The behavior or its consequences cause clinically significant distress or interference in interpersonal, academic, or other important areas of functioning.
- (F) The behavior does not occur exclusively during psychotic episodes, delirium, substance intoxication, or substance withdrawal. In individuals with a neurodevelopmental disorder, the behavior is not part of a pattern of repetitive stereotypies. The behavior is not better explained by another mental disorder or medical condition (e.g., psychotic disorder, autism spectrum disorder, intellectual disability, Lesch-Nyhan syndrome, stereotyped movement disorder with self-injury, trichotillomania [hair pulling disorder], and excoriation [skin picking disorder]).

The criteria were reformulated as questions. Interrater reliability estimates for the diagnosis of NSSI were very good ($\kappa = 0.90$). Suicide attempts were also assessed at the end of the interview. Master's students in clinical child psychology were first systematically trained in conducting the interviews.

Participants were administered the Structured Clinical Interview for *DSM-IV* Axis II personality disorders [SCID-II; 29] to assess personality disorders. The SCID-II was found to be suitable for use among adolescents [28].

The *Global Assessment of Functioning* (GAF) [29] assesses overall patient functioning and symptom severity; these characteristics have been reliably associated with clinical diagnosis, psychopathologic symptoms, and other clinical outcome ratings [30, 31].

The *Questionnaire of Thoughts and Feelings* (QTF) is a self-report scale (37 items) designed to measure borderline-specific basic assumptions and negative feelings [32]. It is based on cognitive models and Linehan's biosocial model of BPD. The internal consistency within our sample was $\alpha = 0.97$.

The *Borderline Symptom List* (BSL-95) [33] is a self-rating instrument for specific assessment of borderline-typical symptomatology. The symptomatology is collected for the last week. The BSL-95 includes 95 items that are based on *DSM-IV* criteria, the revised version of the Diagnostic Interview for Borderline Personality Disorder, and the opinions of both clinical experts and borderline patients. It consists of seven subscales assessing self-perception, affect regulation, self-destruction, dysphoria, loneliness, intrusions, and hostility. Within our sample the internal consistency for the subscales ranged from $\alpha = 0.84$ to 0.96 . The internal consistency within the present sample for the total score was $\alpha = 0.98$.

The *Difficulties in Emotion Regulation Scale* (DERS) [34, 35] is a 36-item self-report questionnaire designed to assess multiple aspects of emotion dysregulation. The measure yields a total score and scores on six subscales (nonacceptance of emotional responses, difficulties engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity). The internal consistency within the present sample was $\alpha = 0.96$ for the total score, and for the subscales it ranged from $\alpha = 0.80$ to 0.93 .

The *Functional Assessment of Self-Mutilation* (FASM) [36, 37] is a self-report measure of the methods, frequency, and functions of NSSI. The internal consistency within our sample was $\alpha = 0.85$ for the overall scale.

The *Youth Self-Report* (YSR) [38, 39] measures a broad range of psychopathology. Internal consistency within the present sample was $\alpha = 0.96$ for the total score, $\alpha = 0.94$ for the internalizing score, and $\alpha = 0.90$ for the externalizing score.

The *Beck Depression Inventory-II* (BDI-II) [40]. The BDI-II consists of 21 items and assesses depressive symptoms in adolescents. The internal consistency within the present sample was $\alpha = 0.96$.

The *Depression Anxiety Stress Scale* (DASS-21) [41, 42]. The DASS is a reliable and valid self-report questionnaire comprising three scales measuring depression, anxiety, and stress. The internal consistency within the present sample was $\alpha = 0.93$ for the depression scale, 0.85 for the anxiety scale, 0.84 for the stress scale, and 0.94 for the total scale.

2.4. Data Analyses. Logistic regression analyses were conducted to evaluate group differences on diagnoses. Independent variables were the group levels, and the dependent variables the disorders. As we were interested in specific group differences, we set up orthogonal comparisons. The first comparison contrasted the nonclinical adolescent group

(NCA) with the clinical groups (CCA, NSSI, NSSI-C). The second comparison contrasted the clinical control adolescents (CCA) with the two NSSI groups (NSSI and NSSI-C, adolescents with or without impairment/distress). The third comparison contrasted the two NSSI groups, that is, the NSSI and NSSI-C groups. Multivariate analyses of variance (MANOVAs) were used to compare the groups (NCA, CCA, NSSI-C, and NSSI) on dependent variables such as internalizing and borderline symptoms, which were arranged based on content-wise criteria. If the Levene test indicated that the variance homogeneity of an outcome was violated, we transformed it for the analysis (log 10 or sqrt). One-way between-groups analyses of variance (ANOVAs) and effect sizes (Cohen's d) were used to assess differences in externalizing psychopathology (YSR external), general psychopathology (YSR total), global functioning (GAF), and difficulties in emotion regulation (DERS). The same orthogonal contrasts as described above were used to analyse group differences. For the comparison of self-injurious behavior between the NSSI groups with and without impairment, two MANOVAs were conducted, for the severity of NSSI (frequencies, and number of methods) and functions of NSSI, respectively. Significance levels were set at $\alpha = 0.05$.

3. Results

3.1. Diagnostic Criteria of NSSI Disorder. The percentages of fulfilled B and C criteria for NSSI and the mean scores of frequency and strength of NSSI symptoms of adolescents with NSSI disorder and of adolescents with NSSI without impairment/distress are presented in Table 2. Data show that for the B criteria, psychological precipitant, frequent urges, and contingent responses were reported by at least 85% of the participants, whereas preoccupation with the behavior and difficulty resisting the urge were reported by less than 50% of the participants. For the C criteria, impairment at leisure time was reported most frequently, and distress was indicated by 69% of the adolescents with NSSI disorder. The highest endorsement (79%) was to the question regarding desire for help, which was added to better operationalize the impairment/distress criteria. This question was also answered affirmatively by 30% of adolescents who denied experiencing impairment or distress due to NSSI.

3.2. Symptoms of NSSI. The frequencies of each methods of self-injury used by the adolescents with NSSI and NSSI-C are presented in Table 3. A group differentiation between minor and moderate/severe methods was not possible, as 94% of the NSSI group and 82% of the NSSI-C group engaged in minor and moderate/severe methods. Table 4 shows the mean number of methods of NSSI performed, the experience of pain, the age of onset of NSSI, and received medical treatment. Further, group differences and effect sizes on severity and functions of NSSI are reported. There was no significant group effect for number of methods used, pain, and age of onset. Moreover, there was no significant group effect for the function of the NSSI behavior, $F(4, 38) = 1.58$, $p = .20$, but the automatic negative reinforcement,

$F(1, 41) = 4.73$, $p = .035$, and positive reinforcement, $F(1, 41) = 6.41$, $p = .015$, were significantly more endorsed by the NSSI group compared with the NSSI-C group, which is also indicated by large effect sizes (Cohen's $d = 1.08, 1.21$).

3.3. Diagnostic Correlates. Axis I and II diagnoses for the clinical samples are reported in Table 5. The mean number of diagnoses was 3.46 (SD = 1.80) for the NSSI group, 1.70 (SD = 1.2) for the CCA group, and 2.09 (SD = 0.70) for the NSSI-C group. According to our data, NSSI was comorbid with other psychopathological disorders in all but two subjects (5%). Major depression was the most frequent comorbidity, followed by social phobia and PTSD. Logistic regression analyses indicated that major depression was significantly more prevalent (OR = 5.78, $p < .05$) among the NSSI group compared with the CCA group. Table 5 shows odds ratios (ORs) and 95% confidence intervals for odds ratios for each diagnosis.

Adolescents with NSSI had relatively more diagnoses of PTSD and suicide attempts compared with the NSSI-C and CCA groups. In our sample, eight adolescents (20.5%) with NSSI fulfilled the criteria for BPD. Adolescents with NSSI but not fulfilling diagnostic criteria for BPD endorsed a mean of 2.3 (SD = 1.56, range 0–4) symptoms of BPD. Most frequent symptoms were, other than self-injurious behavior, affective instability and inappropriate, intense anger. Least frequent symptoms were identity disturbances and paranoid ideation/severe dissociative symptoms.

3.4. Clinical Correlates. Table 6 shows results of one-way ANOVAs and MANOVAs. MANOVAs were performed for group comparisons of internalizing psychopathology (BDI-II, DASS subscales, and YSR internal) and symptoms of BPD (QTF and BSL-95). As expected, the NCA group showed the lowest scores of psychopathology. The NSSI group had significantly higher symptoms of depression (DASS and BDI) compared with the CCA group; there were no significant differences in anxiety symptoms. For the comparison of the QTF and BSL-95 scores, adolescents with BPD were excluded from adolescents with NSSI disorder. Between adolescents with NSSI disorder without BPD (QTF: Mdn = 3.24; BSL-95: Mdn = 173.34) and adolescents with NSSI disorder and BPD (QTF: Mdn = 3.54; BSL-95: Mdn = 185.06) there was no significant difference, and effect sizes were small regarding the QTF total score ($U = 59.50$, $p = .39$, $r = 0.17$) and the BSL-95 total score ($U = 37.00$, $p = .84$, $r = 0.05$), but results have to be interpreted with caution as the sample size of adolescents with NSSI and BPD was very small ($n = 8$).

The one-way ANOVAs yielded significant group differences for functional impairment (GAF), general psychopathology (YSR), externalizing symptoms (YSR external), and difficulties in emotion regulation (DERS) between nonclinical and clinical groups as well as between clinical controls and adolescents with NSSI. The differences between the NSSI and NSSI-C groups were statistically not significant but showed a trend toward higher psychopathology of the NSSI group.

TABLE 2: Frequency and percentage of the proposed B and C diagnostic criteria for NSSI for the DSM-5, of adolescents with NSSI (NSSI disorder) and adolescents with NSSI without impairment/distress (NSSI-C).

Proposed criterion	NSSI disorder (<i>n</i> = 39) No. (%)	NSSI disorder frequency ^a M (SD)	NSSI disorder strength ^b M (SD)	NSSI-C (<i>n</i> = 10) No. (%)
B1: Psychological precipitant	38 (97.4)			10 (100)
Sadness	30 (76.9)	2.29 (0.98)	2.38 (0.95)	7 (70.0)
Tension	29 (74.4)	1.82 (1.02)	1.89 (1.09)	5 (50.0)
Anger	24 (61.5)	1.68 (1.14)	1.69 (1.19)	6 (60.0)
Distress	23 (59.0)	1.66 (1.19)	1.70 (1.18)	5 (50.0)
Self-criticism	19 (48.7)	1.38 (1.18)	1.50 (1.23)	6 (60.0)
Anxiety	8 (20.5)	0.76 (1.13)	0.83 (1.12)	2 (20.0)
B2:				
Preoccupation with behaviour	18 (46.2)			7 (70.0)
Difficulties resisting the urge	15 (38.5)	2.47 (0.80)		4 (40.0)
B3: Urge occurs frequently	35 (89.7)	2.42 (0.72)	2.44 (0.64)	5 (50.0)
B4:				
Contingent response	34 (87.2)			7 (70.0)
Relief from negative feelings				
Before	10 (25.6)	0.63 (1.00)		4 (40.0)
During	14 (35.9)	1.00 (1.19)		3 (30.0)
After	21 (53.8)	1.66 (1.24)		7 (70.0)
Fewer interpersonal problems				
Before	2 (5.1)	0.15 (0.59)		2 (20.0)
During	5 (12.8)	0.35 (0.86)		2 (20.0)
After	4 (10.3)	0.34 (0.82)		3 (30.0)
Feel better				
Before	7 (17.9)	0.47 (0.98)		4 (40.0)
During	9 (23.1)	0.68 (1.12)		2 (20.0)
After	18 (46.2)	1.32 (1.32)		6 (50.0)
Reward				
Before	1 (2.6)	0.11 (0.52)		0 (0)
During	1 (2.6)	0.08 (0.50)		0 (0)
After	4 (10.3)	0.27 (0.80)		0 (0)
Preventing suicide attempt				
Before	7 (17.9)	0.94 (1.08)		1 (10.0)
During	6 (15.4)	0.38 (0.87)		2 (20.0)
After	3 (7.7)	0.28 (0.77)		0 (0)
C: Distress, Impairment				
Impairment	39 (100)	1.97 (0.77)		0 (0)
Home	9 (23.1)	0.94 (0.95)		0 (0)
School	8 (20.5)	0.94 (0.93)		0 (0)
Leisure time	13 (33.3)	1.12 (1.02)		0 (0)
Friends	10 (25.6)	0.88 (.99)		0 (0)
Distress	27 (69.2)			0 (0)
Want help:	31 (79.5)			3 (30)

Note. ^aFrequency scale 0–3 (0 = never, 1 = sometimes, 2 = often, 3 = very often) ^bStrength scale 0–3 (0 = not at all, 1 = a little, 2 = strong, 3 = very strong).

TABLE 3: Frequency of methods of self-injurious behaviour assessed by the FASM in adolescents with NSSI (NSSI disorder) and adolescents with NSSI without impairment/distress (NSSI-C).

Method	NSSI disorder (<i>n</i> = 33)		NSSI-C (<i>n</i> = 11)	
	No.	(%)	No.	(%)
Moderate/severe NSSI				
Cutting/carving on skin	32	(97.0)	9	(81.8)
Scraping	21	(63.6)	8	(72.7)
Burning skin	13	(39.4)	5	(45.5)
Rubbing skin to draw blood	9	(27.3)	3	(27.3)
Self-tattooing	3	(9.1)	1	(9.1)
Total moderate/severe methods	33	(100)	10	(90.9)
Minor NSSI				
Picking at a wound	24	(72.7)	7	(63.6)
Biting self	23	(69.7)	3	(27.3)
Hitting self	19	(57.6)	6	(54.4)
Inserting objects under skin or nails	9	(27.3)	0	(0)
Pulling out one's own hair	6	(18.2)	0	(0)
Picking areas of the body to the point of drawing blood	6	(18.2)	0	(0)
Total minor methods	31	(93.3)	10	(90.9)

Note. FASM: Functional Assessment of Self-Mutilation.

TABLE 4: Means, standard deviations (SDs), and effect sizes (Cohen's *d*) of the FASM, in adolescents with NSSI (NSSI disorder) and adolescents with NSSI without impairment/distress (NSSI-C).

FASM item	NSSI disorder (<i>n</i> = 33) M (SD)	NSSI-C (<i>n</i> = 12) M (SD)	<i>F</i> (1, 41)	Cohen's <i>d</i>
No. of methods used	5.42 (2.18)	4.12 (2.00)	3.03	0.62
Pain ^a	3.18 (0.98)	2.91 (0.70)	0.72	0.32
Medical treatment by medical staff	No. 4 (12.1%)	No. 1 (8.3%)	$\chi^2 = 0.11$	
Age of onset (years)	13.05 (1.73)	13.00 (2.41)	0.01	0.02
Function			<i>F</i> (4, 38) = 1.58	
Automatic negative reinforcement	2.43 (0.84)	1.54 (0.81)	4.73*	1.08
Automatic positive reinforcement	2.08 (0.71)	1.33 (0.51)	6.41*	1.21
Social negative reinforcement	0.42 (0.48)	0.27 (0.34)	0.95	0.36
Social positive reinforcement	0.58 (0.37)	0.64 (0.58)	0.20	0.06

Note. ^aOn a scale from 4 (no pain) to 1 (severe pain); * *p* < .05.

4. Discussion

We examined the proposed *DSM-5* criteria for an NSSI disorder in a female inpatient adolescent sample and investigated diagnostic and clinical correlates of NSSI, comparing adolescents with NSSI disorder, adolescents with NSSI without impairment/distress, adolescents with mental disorders without NSSI, and adolescents with no mental disorders. The results indicated that with the currently proposed *DSM-5* criteria for an NSSI disorder, a sample of adolescents could be identified who were more impaired than adolescents who were also hospitalized due to mental disorders but did not engage in NSSI. In addition, 80% of the adolescents with NSSI disorder did not meet criteria for BPD, supporting the evidence for a distinct diagnostic entity.

For the proposed *DSM-5* diagnostic criteria for an NSSI disorder, in criteria B (intentional injury is associated with at least two of four symptoms) the highest frequency of agreement was for psychological precipitant, especially sadness and tension, and contingent response, especially relief from negative feelings. The lowest agreement was for preoccupation with the behavior. Results are in line with a community study [11], although they assessed criterion B1 (psychological precipitant) with two items of the FASM and we asked which feelings they experienced just before self-injuring. As in the Zetterqvist et al. [11] study, in our sample there were some (*n* = 12, 29% of adolescents of the NSSI group) who fulfilled the NSSI criteria A, B, D, and E but denied that the behavior caused them any impairment or distress. There is currently a general discussion on whether the impairment/distress

TABLE 5: Diagnostic correlates of adolescents with clinical diagnoses without NSSI (CCA), adolescents with NSSI without impairment/distress (NSSI-C), and adolescents with NSSI (NSSI), as well as logistic regressions and orthogonal comparisons between clinical controls and NSSI (CCA versus NSSI) and between NSSI disorder and NSSI-C (NSSI versus NSSI-C).

	CCA (<i>n</i> = 20) <i>N</i> (%)	NSSI-C (<i>n</i> = 11) <i>N</i> (%)	NSSI (<i>n</i> = 39) <i>N</i> (%)	CCA versus NSSI exp(<i>b</i>) = OR [95% CI]	NSSI versus NSSI-C exp(<i>b</i>) = OR [95% CI]
Major depression	6 (30)	8 (72.7)	31 (79.5)	5.78 [1.12–29.85]*	1.36 [0.29–6.34]
Social phobia	5 (25)	3 (27.3)	15 (38.5)	1.05 [0.20–5.60]	1.82 [0.41–8.00]
PTSD	1 (5)	2 (18.2)	11 (28.2)	4.00 [0.32–50.23]	1.90 [0.35–10.28]
BPD	0	0	8 (20.5)	NA	NA
Specific phobia	4 (20)	1 (9.1)	7 (17.9)	0.53 [0.05–5.86]	2.33 [0.26–21.36]
ODD	2 (10)	1 (9.1)	5 (12.8)	0.85 [0.07–10.61]	1.56 [0.16–15.00]
Bulimia Nervosa	0	0	5 (12.8)	NA	NA
Dysthymia	2 (10)	2 (18.2)	4 (10.3)	1.89 [0.23–15.74]	0.55 [0.09–3.47]
Conduct disorder	0	0	4 (10.3)	NA	NA
OCD	4 (20)	0	2 (5.1)	NA	NA
Agoraphobia	2 (10)	1 (9.1)	2 (5.1)	1.80 [0.10–31.99]	0.57 [0.05–6.97]
ADHD	0	0	2 (5.1)	NA	NA
Anorexia nervosa	3 (15)	2 (18.2)	1 (2.6)	1.19 [0.17–8.47]	0.13 [0.01–1.54]
Panic disorder	1 (5)	0	1 (2.6)	NA	NA
GAD	2 (10)	0	1 (2.6)	NA	NA
Suicide attempts	4 (20)	6 (54.4)	27 (69.2)	4.50 [0.89–22.74]	1.88 [0.48–7.36]
Smoking	2 (10)	3 (27.3)	21 (53.8)	3.38 [0.47–24.29]	3.11 [0.72–13.51]
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>T</i> (67)	<i>T</i> (67)
No. of diagnoses	1.70 (1.22)	2.09 (0.70)	3.46 (1.80)	2.50**	2.62, <i>p</i> = .07 <i>d</i> = 1.0

Note. * $p < .05$, ** $p < .01$. ADHD: Attention deficit hyperactivity disorder, ODD: Oppositional Deviant Disorder, GAD: Generalized Anxiety Disorder, BPD: Borderline Personality Disorder, OCD: Obsessive Compulsive Disorder, PTSD: Posttraumatic Stress Disorder, NA: not applicable.

criterion should be part of each diagnosis [43] and given the difficulty of objectively operationalizing impairment and distress [44]. Especially for patients with NSSI this might be a difficult question. These patients may see NSSI as a (temporary) solution to reduce distress [10, 11], and so they do not report impairment or distress. In an attempt to better operationalize the impairment/distress criterion, in the structured diagnostic interview Kinder-DIPS [45] there is an additional question: “Do you want help for this problem?” Whereas distress was reported by 69% of adolescents with NSSI disorder, a desire for help was affirmed by 80% and also by 30% of adolescents who denied having impairment or distress due to NSSI. When we compared the NSSI and NSSI-C groups, we found significantly less automatic positive and negative reinforcement as functions of NSSI in the NSSI-C group; furthermore, the NSSI-C group did not fulfil criteria for BPD, had fewer externalizing disorders, and, although not significant, showed a trend of reporting fewer depressive and borderline symptoms and less difficulties in emotion regulation. Future research using larger sample sizes should elaborate on this issue.

The most common methods used for NSSI were cutting, carving, and scraping. This is in accordance with related literature [22, 46, 47]. The method “picked at a wound” should, as also suggested by others [11, 46], be excluded, as

this method was also endorsed by 22% of adolescents in the nonclinical group. We were unable to differentiate between adolescents performing minor and moderate/severe NSSI methods due to a huge overlap. In the sample with NSSI disorder, the mean number of types of NSSI performed was 5.42, mean age of onset was 13 years, and 12% had received medical treatment. NSSI is mostly an impulsive behavior that 87% of the adolescents with NSSI disorder reported not thinking about at all or in the few minutes before engaging in NSSI. The most frequently reported functions were positive and negative automatic reinforcement, in line with [11].

As far as we know, this is the first study using clinical structured interviews and the suggested *DSM-5* criteria for NSSI to examine diagnostic correlates. Findings suggest that NSSI is comorbid with a wide range of diagnoses. The most common comorbid diagnoses were major depression, PTSD, and social phobia, supporting the results of others [13, 21] and a review by Nitkowski and Petermann [48]. Results are also in line with the chart review of inpatient adults with NSSI [15], characterized by high rates of internalizing disorders like depressive and anxiety disorders. All but one subject had at least one Axis I disorder in the Selby et al. [15] study; similarly, in our sample there were two adolescents with NSSI disorder without any comorbid diagnosis. The comorbidity with externalizing disorders would probably

TABLE 6: Clinical correlates of non-clinical adolescents (NCA), clinical controls (CCA), adolescents with NSSI without impairment/distress (NSSI-C), and adolescents with NSSI disorder (NSSI), as well as MANOVA and ANOVA with orthogonal contrasts and effect sizes (Cohen's *d*) between non-clinical and clinical groups (NCA versus rest), clinical controls and NSSI (CCA versus NSSI total), and NSSI disorder versus NSSI-C.

Questionnaire	NCA M (SD)	CCA M (SD)	NSSI-C M (SD)	NSSI M (SD)	NCA versus rest	Cohen's <i>d</i>	CCA versus NSSI total	Cohen's <i>d</i>	NSSI disorder versus NSSI-C	Cohen's <i>d</i>
ANOVA										
GAF	94.20 (3.87)	59.55 (6.40)	56.27 (4.50)	53.70 (10.17)	<i>T</i> (91.52) 34.84**	7.26	<i>T</i> (40.22) -2.55*	0.80	<i>T</i> (38.67) 1.19	0.38
YSR Total ^a	51.60 (14.23)	83.79 (19.13)	98.93 (18.11)	111.31 (26.77)	<i>T</i> (92) 11.72**	2.44	2.97**	0.62	<i>T</i> (92) 1.22	0.25
YSR_EXT ^a	8.08 (4.32)	12.91 (1.74)	18.28 (9.38)	21.31 (11.32)	5.89**	1.23	2.17*	0.45	0.48	0.10
DERS	70.59 (16.89)	97.79 (24.14)	108.16 (17.55)	123.42 (25.80)	8.25**	1.72	2.76**	0.58	2.09	0.44
MANOVA 1					<i>F</i> (3, 92)				<i>F</i> (3, 92)	
DASS depression ^b	1.25 (1.76)	8.84 (5.73)	11.83 (6.37)	13.82 (4.56)	165.85**	2.88	7.86**	0.81	1.51	0.41
DASS anxiety ^b	1.84 (2.19)	7.63 (4.49)	7.56 (4.71)	8.95 (5.26)	68.08**	1.89	0.11	0.17	0.80	0.28
DASS stress ^b	3.68 (2.74)	8.83 (4.40)	10.60 (4.37)	11.38 (4.60)	71.73**	1.88	2.71	0.54	0.20	0.16
BDI ^b	5.57 (5.87)	23.36 (13.11)	30.22 (9.38)	36.32 (12.32)	155.19**	2.70	11.07**	1.03	3.16	0.74
YSR_INT ^b	8.18 (6.58)	25.28 (9.67)	31.37 (8.29)	33.75 (10.04)	169.24**	2.78	6.47*	0.91	0.51	0.29
MANOVA 2					<i>F</i> (3, 72)				<i>F</i> (3, 72)	
QTF ^{ac}	1.44 (0.36)	2.33 (0.90)	2.99 (0.48)	3.21 (0.83)	100.00**	2.42	12.91**	0.94	0.25	0.42
BSL-95 ^{ac}	38.04 (17.47)	120.47 (76.01)	140.80 (64.29)	186.62 (64.93)	108.38**	2.45	4.79*	0.75	1.69	0.62

Note. GAF: Global Assessment of Functioning; YSR: Youth Self Report, INT: internal, EXT: external; DASS: Depression Anxiety Stress Scales; BDI: Beck's Depression Inventory; QTF: Questionnaire of Thoughts and Feelings; BSL-95: Borderline Symptom List; DEFS: Difficulties in Emotion Regulation Scale; * *p* < .05; ** *p* < .01; *** *p* < .001. ^alog transformed, ^bSQRT transformed, ^cadolescents with BPD were excluded from these analyses.

even be higher if the recruitment of this study would not focus on inpatient psychiatric adolescents as in Switzerland female adolescents with externalizing disorders are often placed in residential group homes with outpatient psychiatric and psychotherapeutic services.

Our finding of a prevalence rate of 20% of adolescents with NSSI disorder also fulfilling diagnostic criteria for BPD corresponds to some studies [24, 48, 49] but is lower than the rate of 50% reported by Nock et al. [13]. On the criteria level, adolescents with NSSI disorder without a comorbid BPD endorsed a mean of 2.3 borderline symptoms compared with a mean of 0.3 endorsed by the clinical control adolescents. The least frequently endorsed criteria of the borderline symptoms were identity disturbances and paranoid/dissociative symptoms. Exploring different borderline features might be interesting, as a longitudinal study showed that behavioral impulsivity was an important symptom in explaining frequency of NSSI, low level of affective instability acted as a protective factor, and an unstable sense of self was less helpful in explaining the presence and initiation of NSSI among adolescents [50]. Dimensionally, adolescents with NSSI disorder were not significantly different from adolescents with BPD, although the scores of the adolescents with NSSI without BPD were lower, and for the BSL-95, below the clinical cut-off. Because self-injurious behavior is a criterion of BPD, there can be an association of NSSI and BPD; however, the current results indicate that NSSI disorder can be present without BPD. Nevertheless, future research has to investigate if adolescents with NSSI might develop additional BPD symptoms over time. Other than BPD, no other personality disorders were diagnosed in this sample. There may be a hesitancy to assign personality disorders in this age group [51].

In light of previous studies [11, 13, 21], a somewhat unexpected result was the low rate of alcohol and substance abuse or dependence. There was one adolescent with NSSI disorder fulfilling criteria for present substance abuse. On the interview on NSSI and in the FASM, three adolescents reported sometimes self-injuring under the influence of alcohol or drugs. One explanation of these results might be that the present sample was inpatient adolescents and therefore they did not have the opportunity to use drugs or alcohol on a regular basis. Furthermore, alcohol use in Switzerland is legal starting at age 16 (beer and wine) or 18 (all alcoholic beverages), respectively; that cultural differences might influence the results on an abuse in adolescents. However, as in other studies [11, 13], 54% of the NSSI group endorsed smoking regularly, compared with 10% of the CCA group.

The majority (69%) of adolescents with NSSI disorder reported a suicide attempt, which is in line with the 70% found in the study by Nock et al. [13]. As all adolescents with NSSI disorder endorsed that they conducted NSSI without suicidal intent, NSSI has to be distinguished from suicidal behavior. This is also supported by the reports of some (18%) adolescents with NSSI disorder indicating that they engaged in NSSI to prevent a suicide attempt. Nevertheless, there is considerable overlap between NSSI and suicidal behavior. In two prospective studies, NSSI was shown to be

a significant predictor for suicide attempts [18–20]. In our study, adolescents with NSSI disorder reported a mean age at onset of NSSI of 13 years, a mean age of 12 years for suicide ideations, and a mean age for the first suicide attempt of 14 years. This would be in line with Joiner's interpersonal theory of suicide [52] that attempting suicide requires both the desire and the capability to attempt suicide, and NSSI correlates with both. NSSI raises capability by allowing individuals to habituate to self-inflicted pain and violence [13] and it heightens risk for suicidal desire through association with emotional and interpersonal distress [18, 53]. Therefore, it is essential to identify why and how NSSI heightens the risk for suicide attempts.

In addition to the diagnostic correlates, clinical correlates indicated that adolescents with NSSI disorder have, compared with adolescents with mental disorders without NSSI and in line with previous research, elevated rates of internalizing and externalizing symptoms [22, 25], low functioning [15], and difficulties in emotion regulation [23]. These findings complement the picture of highly impaired adolescents with NSSI disorder.

Several limitations of this study should be noted. Our sample consisted of female adolescents admitted to a psychiatric unit and thus may not generalize to other samples. Second, our data were cross-sectional. Third, our subsample sizes were small, so the power was limited for some analyses. Fourth, even though NSSI will be a disorder in Section 3 of the *DSM-5* [9], the proposed criteria are not finalized.

Strengths of the study were the use of the proposed *DSM-5* diagnostic criteria for NSSI, tackling the problems of previous research on self-injury, where different definitions were used, and investigating samples with repetitive and single episodes of NSSI. Another strength is the use of a multimethod assessment, employing self-report measures and structured clinical interviews.

Implications of these results are that a precise and comprehensive diagnostic assessment including NSSI should be conducted routinely. On one side, NSSI is a highly impairing disorder on its own for the patients themselves, relatives, and friends, and on the other side, it is also a risk factor for suicidal behavior. In summary, our study suggests that the proposed *DSM-5* criteria for NSSI are useful and necessary to promote research on aetiology, course, and the development of effective treatment strategies and interventions for adolescents suffering from NSSI.

Conflict of Interests

The authors declare that they have nonfinancial competing interests.

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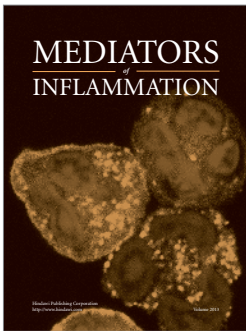
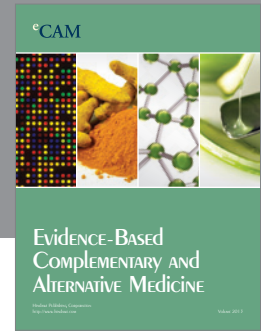
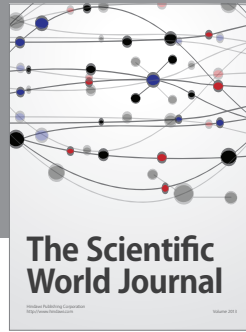
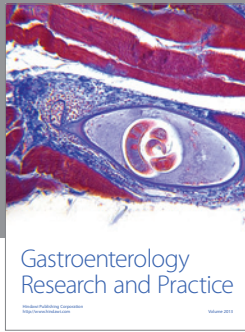
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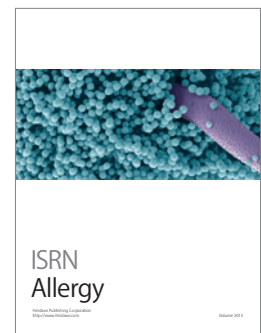
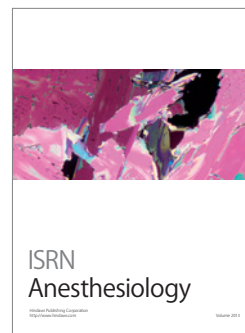
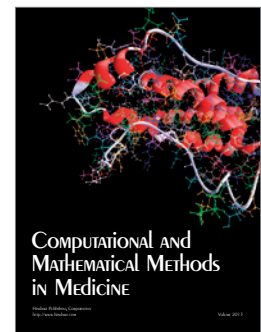
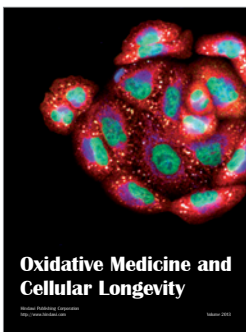
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Running Head: Personality in adolescents with nonsuicidal self-injury

Temperament and character traits in female adolescents with a diagnosis of nonsuicidal self-injury with and without comorbid borderline personality disorder

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Abstract

Nonsuicidal self-injury (NSSI) has been included in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; section 3) as a condition requiring further study. Another important change in *DSM-5* is the proposition of a dimensional concept for personality psychopathology. The present study investigated differences in personality traits in adolescents with NSSI using the Junior Temperament and Character Inventory (JTICI). Previous studies showed high novelty seeking, especially impulsivity, paired with high harm avoidance in patients with self-injurious behavior (SIB) compared to other patients. Most of the studies included patients with SIB and borderline personality disorder (BPD) or did not control for comorbid BPD. Participants in this study were 57 female adolescents with NSSI disorder without BPD (NSSI-BPD), 14 adolescents with NSSI disorder and BPD (NSSI+BPD), 32 clinical controls (CC), and 64 nonclinical controls (NC). Impulsivity was assessed by self-report questionnaires and a Go/No Go task. Results showed the following significant differences: NSSI groups scored higher on harm avoidance and lower on persistence, self-directedness and cooperativeness than CC. NSSI+BPD scored even than NSSI-BPD on persistence and cooperativeness scales and higher on harm avoidance. For novelty seeking, NSSI-BPD reached a higher score than CC, but a lower score than NSSI+BPD. Adolescents with NSSI reported higher levels of impulsivity than the CC and NC group. However, this difference was not found in a Go/No Go task. Adolescents with NSSI-BPD showed impairment in several personality dimensions assessed by the JTICI, however they were not as impaired as adolescents with NSSI+BPD. This might provide further evidence for a distinct diagnostic entity of NSSI disorder.

Key words: Nonsuicidal self-injury, borderline personality disorder, temperament, character, impulsivity, Go/No Go, novelty seeking

Temperament and character traits in adolescents with a diagnosis of nonsuicidal self-injury
with and without comorbid borderline personality disorder

Due to the inclusion of nonsuicidal self-injury (NSSI) in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; section 3; American Psychiatric Association, 2013) as a distinct disorder a differentiation between adolescents with NSSI disorder with and without comorbid borderline personality disorder (BPD) is required. High prevalence rates, even in a community sample (Zetterqvist, Lundh, Dahlström, & Svedin, 2013), as well as high comorbidity rates (Klonsky & Muehlenkamp, 2007; Yates, 2004), low quality of life (In-Albon, Ruf, & Schmid, 2013), and high risk for suicidality (Victor & Klonsky, 2014), highlight the importance of further research on NSSI. Special attention should be paid to identify those suffering from severe repetitive NSSI using a variety of self-harming methods because they are at risk for chronification (Manca, Presaghi & Cerutti, 2014, Glen & Klonsky, 2011). Linehan (1993) highlights the role of temperament in the development and maintenance of NSSI and BPD. Indeed, personality traits might be a relevant risk factor for NSSI (Nock, 2010; Hefti, In-Albon, Schmeck, & Schmid, 2012). In line with this, a highly harmful temperament profile in patients with BPD was identified, comprised of high harm avoidance and novelty seeking (Barnow et al., 2005; Cloninger, 2002; Ha et al., 2004; Joyce et al., 2003; Kaess et al., 2013). Increased harm avoidance in adolescence even predicted BPD in adults (Arens, Grabe, Spitzer, & Barnow, 2011). According to Cloninger et al. (1994), a personality pattern consisting of high novelty seeking and high harm avoidance represents an approach-avoidance conflict that may cause affective instability, a core feature of BPD.

As only a minority of adolescents with NSSI suffers from BPD (In-Albon et al., 2013, Schmid et al., 2008, Zlotnick et al., 1999), studies with adolescents with NSSI disorder without BPD are needed to validate the link between this personality pattern and NSSI. Higher levels of *novelty seeking* were found in adolescents with SIB compared to those

without SIB (Hefti et al., 2013). Furthermore, adolescent patients with depression and SIB reported more harm avoidance than those without SIB (Joyce, Light, Rowe, Cloninger, & Kennedy, 2010). However, none of these studies controlled for comorbid BPD. Adolescents with NSSI not fulfilling BPD criteria report more borderline personality symptoms than adolescents without NSSI, raising the question if personality disorders should rather be viewed as a dimensional and not categorical construct. In fact, *DSM-5* describes an “Alternative Model for Personality Disorders” (APA, 2013) consisting of a dimensional and categorical construct of personality functioning or psychopathology.

Among different personality concepts, Cloninger’s (1987) biopsychosocial personality model seems to be able to describe healthy as well as pathological personality traits, and to differentiate between patients with and without personality disorders (Barnow et al. 2006, Herpertz et al. 2006, Schmeck et al. 2013). Cloninger’s (1987) model divides personality into temperament, viewed as stable (Goldsmith et al., 1987) and heritable (Cloninger et al., 1993), and character, influenced by sociocultural learning (Cloninger, Svrakic & Przybeck, 1993). As shown in Table 1, the model includes four temperament (novelty seeking, harm avoidance, reward dependence, persistence) and three character dimensions (self-directedness, cooperativeness, self-transcendence). According to Cloninger (2000), personality disorders are characterized by low levels of self-directedness, cooperativeness, and self-transcendence; at least for low self-directedness and low cooperativeness evidence exists (Svrakic et al., 1993). Low *self-directedness* is related to adult depression (Richter & Eisemann, 2002), to BPD in adolescents (Barnow et al., 2005; Kaess et al., 2013) and to SIB in adolescents (Hefti et al., 2013; Joyce et al., 2010). Low *cooperativeness* is associated with aggressive and delinquent behavior (Kim et al., 2006). A higher cooperativeness was found in female adolescents with SIB compared to those without SIB (Ohman et al., 2008), whereas adolescents with BPD showed lower cooperativeness than control adolescents (Barnow et al.,

2005). High *self-transcendence* is linked to SIB in adolescents (Hefti et al., 2013) and to BPD in adolescents (Barnow et al., 2005). Low *reward dependence* is linked to internalizing symptoms like depression and anxiety (Kim et al., 2006), but no association has been found between reward dependence and SIB (Hefti, In-Albon, & Schmid, 2013; Joyce et al., 2010; Ohmann et al., 2008). Kaess et al. (2013) found a lower reward dependence in adolescents with BPD than in clinical and healthy controls. *Persistence* is neither linked to BPD (Barnow et al., 2005; Kaess et al., 2013) nor to SIB (Hefti et al., 2013; Joyce et al., 2010; Ohmann et al., 2008). High *novelty seeking* seems to be part of the highly impairing temperament profile in SIB. One part of novelty seeking, impulsivity, might explain the difficulties patients with NSSI have to resist the urge to injure themselves (Glenn & Klonsky, 2010). NSSI itself is often an impulsive act, as most of the individuals with NSSI think less than five minutes before committing the act (Nock & Prinstein, 2005).

Indeed, individuals with NSSI indicated on self-report measures higher impulsivity than individuals without NSSI (Claes & Muehlenkamp, 2013; Glenn & Klonsky, 2010; Janis & Nock, 2009), and patients with repetitive NSSI reported even higher impulsivity than patients with onetime SIB (Evans, Platts, & Liebenau, 1996). However, previous research has found low convergence between self-report and behavioral measures of impulsivity (Gerbing, Ahadi, & Patton, 1987; Enticott, Ogloff, & Bradshaw, 2006). Therefore, it seems important not only to investigate impulsivity with self-report measures, but also with behavioral tasks.

Response inhibition, one aspect of impulsivity, can be measured with a Go/No Go task. Janis and Nock (2009) compared self-reported impulsiveness with experimentally assessed impulsiveness in adolescents with NSSI behavior. While participants with NSSI scored higher on self-reported impulsiveness, they did not differ from the comparison group on behavioral measures. This result has been replicated in studies with adults with NSSI (Glenn & Klonsky, 2010; Mc Closkey, Look, Chen, Pajoumand, & Berman, 2012). The difference between self-

reported and experimentally assessed impulsivity may be explained by the measurement of different impulsivity constructs. While self-report questionnaires measure general response tendencies (traits), behavioral tasks may rather measure spontaneous reactions that are influenced by current cognitive processes (Mc Closkey et al., 2012).

In sum, previous research is consistent with the notion that heritable temperament traits are underlying features of BPD symptoms. However, it remains unclear, if the same pattern can be found in a sample of adolescents with NSSI disorder without BPD. None of the presented studies assessed NSSI according to the *DSM-5* criteria (Hefti et al., 2013; Joyce et al., 2010; Ohmann et al., 2008). Thus, the samples were heterogeneous. Whereas Hefti et al. (2010) investigated a school sample, Joyce et al. (2010) investigated depressed adolescents with and without SIB, and Ohmann et al. (2008) investigated a clinical population of in- and outpatients. To our knowledge, no study investigated impulsivity or other personality traits in adolescents with NSSI disorder (according to *DSM-5*), nor differences in personality dimensions between adolescents with NSSI with and without BPD.

Therefore, the aim of the present study was to shed more light onto the difference between NSSI and BPD by investigating personality functioning, to improve the process of finding indications for different treatments. Second, it is important to compare temperament and character traits of NSSI to a clinical (CC) and a nonclinical control group (NC), for the examination of how specific these traits are for individuals with NSSI. NSSI disorder was assessed according to the *DSM-5* research criteria and personality traits were assessed according to Cloninger's (1987) model for personality. Taking the results of previous studies into account, we hypothesized that adolescents with NSSI show higher values on novelty seeking, self-transcendence and harm avoidance and lower values on self-directedness compared to NC and CC. Previous studies regarding cooperativeness and NSSI are

inconsistent, therefore group differences were analyzed. As one part of novelty seeking, impulsivity was investigated using a self-report questionnaire and a Go/No Go task.

Methods

Participants

Participants were 167 female adolescents, aged 12-19 years ($M = 15.94$, $SD = 1.47$), recruited from different inpatient psychiatric units in Switzerland and Germany. Participants included 57 adolescents fulfilling the *DSM-5* research criteria for NSSI disorder (NSSI), but not for BPD, 14 adolescents with NSSI and BPD (NSSI+BPD), 32 adolescents with a *DSM-IV* (American Psychiatric Association, 1994) diagnosis other than NSSI (clinical controls, CC), and 64 nonclinical adolescents who had no current or past experience of mental disorder (nonclinical controls, NC). Participants were similar with respect to age, Welch's $F(3, 47.19) = 0.41$. Psychosocial characteristics of adolescents with NSSI disorder, CC, and NC groups are reported in Table 2. Regarding nationalities, most of our participants were Swiss and German, except for two Italians, one Thai and one Pole. The three most frequent mental disorders in all groups were major depression (37.50% in CC, 70.18% in NSSI, 78.6% in NSSI+BPD), social phobia (34.38% in CC, 36.84% in NSSI, 42.9% in NSSI+BPD), and specific phobia (28.13% in CC, 19.30% in NSSI, 35.70% in NSSI+BPD). Posttraumatic stress disorder was a common comorbid disorder in NSSI (14.04%) and NSSI+BPD (50%), only two participants of the CC suffered from PTSD (6.25%). Groups differed significantly regarding depression, $\chi^2(2) = 11.87$, $p < 0.01$, and PTSD, $p < 0.01$, according to a two-sided Fisher's exact test. There were no significant differences regarding any other *DSM-IV* disorders assessed with clinical interviews. Further comorbid diagnoses of the clinical groups were dysthymia, oppositional defiant disorder, ADHD, conduct disorder, bulimia nervosa, anorexia nervosa, obsessive-compulsive disorder, agoraphobia, panic disorder, and generalized anxiety disorder. Groups did significantly differ regarding the number of diagnoses, $F(2, 100) = 30.37$, $p < 0.01$, patients in the BPD group met

significantly more diagnoses than the other groups ($M = 5.43$, $SD = 1.83$), and NSSI met significantly more diagnoses ($M = 3.39$, $SD = 1.36$) than clinical controls ($M = 2.03$, $SD = 1.00$).

Measures

Diagnostic assessments

To examine the participants' current or past *DSM-IV-TR* diagnoses for Axis I disorders, we conducted a structured interview with each adolescent. The *Diagnostic Interview for Mental Disorders in Children and Adolescents (Kinder-DIPS)* (Schneider, Unnewehr, & Margraf, 2009) assesses the most frequent mental disorders in childhood and adolescence. Questions for substance use disorders and BPD were asked from the adult DIPS (Schneider & Margraf, 2011). The Kinder-DIPS has good validity and reliability for axis I disorders (child version, $kappa = 0.48-0.88$) (Neuschwander, In-Albon, Adornetto, Roth, & Schneider, 2013; Schneider et al., 2009). NSSI was assessed according to the *DSM-5* research criteria, with as questions reformulated criteria. Interrater reliability estimates for the diagnosis of NSSI were very good ($kappa = 0.90$). Master's students in clinical child psychology were first systematically trained in conducting the interviews.

Participants were administered the *Structured Clinical Interview for DSM-IV Axis II (SCID-II)*, (Fydrich, Renneberg, Schmitz, & Wittchen, 1997) to assess personality disorders. The SCID-II was found to be suitable for the use among adolescents (Salbach-Andrae et al., 2008).

The *Junior Temperament and Character Inventory (JTCI)* (Goth & Schmeck, 2009) is a self-report measure assessing the seven personality traits based on Cloningers (1987) biopsychosocial model of personality. The scales have good levels of internal consistency, with Cronbach's α ranging from 0.79 to 0.85 (Goth & Schmeck, 2009). The internal consistency within the present sample was $\alpha = 0.84$.

The *Barratt Impulsiveness Scale (BIS)* (Barratt, 1959), German version (Hartmann, Rief, & Hilbert, 2011) is a widely used self-report questionnaire to assess impulsive personality traits

with three subscales: Attentional, motor, and nonplanning impulsivity. The BIS demonstrated good psychometric properties (Barratt, 1959; Fossati et al., 2001, Hartmann et al., 2011). The internal consistency within the present sample was $\alpha = 0.81$.

The *Youth Self Report* (YSR) (Achenbach, 1991; Döpfner, Melchers, & Fegert, 1994) measures a broad range of psychopathology. Internal consistency within the present sample was $\alpha = 0.94$ for the total score, $\alpha = 0.94$ for the internalizing score, and $\alpha = 0.79$ for the externalizing score.

The *Beck Depression Inventory-II* (BDI-II) (Hautzinger, Keller, & Kühner, 2006). The BDI-II consists of 21 items and assesses depressive symptoms in adolescents. The internal consistency within the present sample was $\alpha = 0.95$.

Non-emotional and emotional Go/No Go task

Participants were instructed to press a button as adequate and as fast as possible if a Go stimulus appears on the screen and to suppress reactions to No Go stimuli. Participants had a test run with six trials, followed by the non-emotional Go/No Go task with 40 trials with “+” and “x” as Go and No Go. Afterwards participants completed an emotional Go/ No Go task with four combinations of angry, happy, and neutral facial expressions with 12 trials for each combination. The following six combinations were presented: x Go / + No Go, + Go / x No Go, Angry Go / Neutral No Go, Happy Go / Neutral No Go, Neutral Go /Angry No Go, Happy No Go/ Neutral Go. For all runs targets occurred on 50% of the trials. The order of the four emotional runs and the trials within each run were randomized across participants.

Facial stimuli consisted of colored angry, happy, and neutral expressions from 18 individuals (9 females) taken from the NimStim Face Stimulus set (Tottenham et al., 2009). Non-emotional stimuli (“+” and “x”) were presented for 200ms and emotional stimuli for 500ms, after a 500ms fixation cross. The interstimulus interval was 1.5 sec, in which a reaction was still

possible. Stimuli were presented with E-Prime (Psychology Software Tools, Inc., Pittsburgh, PA, USA), and simultaneously omission (no reaction to Go) and commission (reaction to No Go) errors as well as reaction time were recorded. Omission errors indicate inattention (Trommer, Hoepfner, Lorber, & Armstrong, 1988), commission errors indicate response inhibition (Schulz et al., 2007), and reaction time to Go stimuli has previously been used as measure of response bias, with faster reactions indicating a response or attention-bias toward the shown emotion (Ladouceur et al., 2006).

Procedure

All participants and their parents were informed about the study and gave their written consent in accordance with the Declaration of Helsinki. The local ethics committee approved the study. First, the clinical interviews were conducted and the questionnaires were distributed and afterwards the Go/No Go task was administered.

Data analyses

Multivariate analyses of variance (MANOVAs) were used to compare the groups (NC, CC, NSSI, NSSI+BPD) on dependent variables such as impulsivity and psychopathology. One-way between-groups analyses of variance (ANOVAs) and effect sizes (Cohen's *d*) were used to further analyze significant group differences of MANOVAs. As we were interested in specific group differences, we set up orthogonal comparisons for psychopathology, personality, and self-reported impulsivity. The first comparison contrasted the NC group with the clinical groups (CC, NSSI, NSSI+BPD), the second contrasted the CC group with the two NSSI groups (NSSI and NSSI+BPD), and the third contrasted the two NSSI groups, the NSSI and NSSI+BPD group.

For the Go/No Go task, a similar analysis strategy was used. First, outliers (z -values > 3) were excluded, then the sensitivity index d' ($z(\text{Reaction rate to Go}) - z(\text{Reaction rate to No Go})$) was calculated, as a measure of discrimination, with lower values representing an inability to distinguish between stimuli and lower performance levels (Pacheco et al., 2012). To examine

group differences, the non-emotional Go/No Go task was evaluated with a one-way ANOVA, and the emotional Go/No Go tasks were analyzed separately for emotional Go (neutral No Go) and for neutral Go (emotional No Go) with MANOVAs. This examination was done for the sensitivity index d' , errors of commission and omission, as well as for the reaction time on Go trials.

If the Levene test indicated that the variance homogeneity of an outcome was violated, we transformed it for the analysis (log10 or sqrt) and if indicated, Greenhouse Geisser corrected values were used. Significance levels were set at $\alpha = 0.05$.

Results

Junior Temperament and Character Inventory

As reported in Table 2, significant group differences were shown on the temperament scales novelty seeking, $F(3, 130) = 4.32, p < 0.01, \eta^2 = 0.09$, harm avoidance, $F(3, 130) = 18.80, p < 0.01, \eta^2 = 0.30$, reward dependence, $F(3, 130) = 6.47, p < 0.01, \eta^2 = 0.13$, and persistence $F(3, 130) = 9.57, p < 0.01, \eta^2 = 0.18$, on the character scale self-directedness, $F(3, 130) = 32.71, p < 0.01, \eta^2 = 0.43$, and cooperativeness, $F(3, 130) = 2.99, p = 0.03, \eta^2 = 0.06$. However, there was no significant group difference regarding self-transcendence, $F(3, 130) = 1.28, p = 0.28, \eta^2 = 0.03$.

Barratt Impulsiveness Scale

A MANOVA was performed for group comparisons on impulsivity with the BIS and its subscales. As expected, the group main effect was significant, $F(3, 82) = 9.21, p < 0.01, \eta^2 = 0.25$, with BPD reporting the highest impulsivity. There was no significant group x impulsivity interaction, $F(6, 164) = 1.36, p = 0.23, \eta^2 = 0.05$. As shown in Table 2, the subsequent one-way ANOVA yielded significant group differences regarding impulsivity for the total scale, $F(3, 130) = 9.21, p < .01, \eta^2 = 0.25$, as well as for the subscales attentional, $F(3, 130) = 7.47, p < 0.01, \eta^2 = 0.21$, and nonplanning impulsivity, $F(3, 130) = 8.32, p < 0.01, \eta^2 =$

0.23, but not for the subscale motor impulsivity $F(3, 130) = 2.13, p = 0.10, \eta^2 = 0.07$. Planned comparisons indicated significant differences between the NC group and clinical groups for the total scale and subscales attentional and nonplanning impulsivity. The CC group is significantly less impulsive than the NSSI groups on every subscale. The NSSI-BPD group differs significantly from the NSSI+BPD group regarding nonplanning impulsivity, but not regarding attentional impulsivity.

Go/No Go-Task

Performance in the non-emotional task

Separate one-way ANOVAs were conducted for every outcome of the Go/No Go task. There was no significant group effect for participant's sensitivity index, $F(3, 151) = 0.93, p = 0.43$, for commission errors, $F(3, 151) = 0.43, p = 0.73$, and no group effect on omission errors, $F(3, 154) = 1.22, p = 0.31$, and reaction time, $F(3, 147) = 2.06, p = 0.11$.

Performance in the emotional task when emotional faces were Go trials and neutral faces were No Go trials

Sensitivity Index d' . The 4 (Group) x 2 (Facial Emotion) ANOVA of participant's sensitivity index indicated no significant interaction, $F(3, 148) = 1.22, p = 0.30$, no significant facial emotion effect, $F(1, 148) = 0.26, p = 0.61$, and no significant group effect, $F(3, 148) = 2.3, p = 0.08$.

Commission error rate (No Go). The 4 (Group) x 2 (Facial Emotion) ANOVA indicated no significant interaction, $F(3, 148) = 0.43, p = 0.73$, and no significant group effect, $F(3, 148) = 1.32, p = 0.27$. There was a significant main effect of facial emotion, $F(1, 148) = 29.83, p < 0.01$, indicating a higher commission error rate for angry faces than for happy faces.

Omission error rate (Go). The 4 (Group) x 2 (Facial Emotion) ANOVA indicated no significant interaction, $F(3, 155) = 1.53, p = 0.21$, and no significant group effect, $F(3, 155) =$

1.56, $p = 0.20$. The main effect facial emotion reached significance, $F(1, 155) = 65.50, p < 0.01$, indicating a higher omission error rate for angry faces than for happy faces.

Reaction time (Go). The 4 (Group) x 2 (Facial Emotion) revealed no significant interaction, $F(3, 154) = 0.03, p = 1.00$, and no significant group effect, $F(3, 154) = 0.19, p = 0.90$. The main effect facial emotion was significant, $F(1, 154) = 20.95, p < 0.01$, indicating a faster reaction to happy compared to angry faces.

Performance in the emotional task when neutral faces were Go trials and emotional faces were No Go trials

Sensitivity Index d' . The 4 (Group) x 2 (Face Emotion) ANOVA of participant's sensitivity index indicated no significant interaction, $F(3, 150) = 0.29, p = 0.83$, no significant Face Emotion effect, $F(1, 150) = 0.03, p = 0.87$, and no significant group effect, $F(3, 150) = 1.84, p = 0.14$.

Commission error rate (No Go). The 4 (Group) x 2 (Face Emotion) ANOVA of participant's commission errors revealed no significant interaction, $F(3, 154) = 0.28, p = 0.84$, and no significant main effect (Face Emotion, $F(1, 154) = 0.02, p = .88$; Group, $F(3, 148) = 0.59, p = 0.62$).

Omission error rate (Go). The 4 (Group) x 2 (Face Emotion) ANOVA revealed no significant interaction, $F(3, 152) = 0.34, p = .80$, no significant main effect of Face Emotion $F(1, 152) = 2.51, p = 0.12$, and no significant, but a trend of a group effect, $F(3, 152) = 2.56, p = 0.06$.

Reaction time (Go). The 4 (Group) x 2 (Face Emotion) ANOVA of participant's reaction time to Go Stimuli indicated no significant interaction, $F(3, 146) = 0.37, p = 0.77$, and no significant group effect, $F(3, 146) = 0.30, p = 0.82$. The main effect Face Emotion was

significant, $F(1, 146) = 11.94, p < 0.01$, indicating a faster reaction to neutral faces, when happy faces serve as No Go compared to angry faces.

Discussion

The aim of the present study was to investigate personality traits on the basis of Cloninger's (1987) personality model, with a special focus on impulsivity in adolescents with NSSI disorder without BPD (NSSI-BPD), adolescents with NSSI disorder and BPD (NSSI+BPD), a clinical and a nonclinical control group. As expected, the groups showed distinct personality features. Adolescents with NSSI scored higher on novelty seeking and harm avoidance and lower on self-directedness, persistence and cooperativeness than clinical controls. In adolescents with NSSI and BPD this personality pattern was even more pronounced than in adolescents with NSSI without BPD. Therefore, we were able to replicate the highly impairing personality pattern consisting of high harm avoidance and novelty seeking in adolescents with BPD as shown by Cloninger (2002) and Kaess et al. (2013). The approach avoidance conflict generated from this pattern might be a reason for the emotional instability patients with BPD experience (Cloninger, 1994). Furthermore, we extended these findings to adolescents with NSSI disorder without BPD, but in these patients the personality pattern is less pronounced. As adolescents with NSSI-BPD show a similar personality pattern as adolescents with NSSI+BPD, even if they do not fulfill all criteria for BPD a dimensional personality model seems useful to better describe and understand adolescents with NSSI-BPD and to prevent further impairment in personality functioning. Most experts support the dimensional personality model (e.g., Bernstein, Iscan, & Maser, 2007; Skodol et al., 2011; Widiger, 2011).

We were able to replicate a lower level of self-directedness in adolescents with NSSI (-BPD and +BPD) than adolescents without NSSI similar to Hefti et al. (2013) and Joyce et al.

(2010). In contrast to Ohmann et al. (2008), we found lower levels of cooperativeness in adolescents with NSSI compared to adolescents without NSSI, but this result is similar to the low level of cooperativeness found in adolescents with BPD (Brown, 2009). Low cooperativeness may cause more interpersonal conflict and distress. In fact, previous research indicates that adolescents with NSSI frequently report problems in social interactions (Adrian et al., 2011). Low levels of self-directedness and cooperativeness, as found in adolescents with NSSI, are seen as core characteristics of individuals with personality disorders (Cloninger, 2000) and therefore might represent a pathological personality trait. The low level of persistence in adolescents with NSSI is consistent with findings, that adolescents with NSSI give up faster pursuing goals, while adolescents without NSSI are more diligent and persevering (Goth & Schmeck, 2009). However it is not consistent with previous research (Hefti et al., 2013; Joyce et al., 2010; Ohmann et al., 2008). All groups were similar regarding self-transcendence, therefore we could not find supporting evidence for a higher self-transcendence like previously reported in adolescents with SIB (Hefti et al., 2013) and adolescents with BPD (Barnow et al., 2005). We can summarize that there is a clear difference in personality traits between adolescents with NSSI+BPD and adolescents with NSSI-BPD, despite the small NSSI+BPD sample size ($n = 14$), as well as between adolescents with NSSI and adolescents with other mental disorders, indicating a significantly more difficult temperament and more impairment in personality functioning in adolescents with NSSI than in adolescents with other mental disorders.

As adolescents with NSSI (-BPD and +BPD) show more novelty seeking than CC, it is not surprising, that they scored higher on all subscales of the Barratt Impulsiveness Scale (attentional, nonplanning, and motor impulsivity). However, this difference was not evident in the Go/ No Go task. Neither a group effect, nor a facial emotion effect emerged in the Go/ No Go task. Happy faces were associated with faster reactions and a lower error rate compared to

angry faces, indicating that happy faces are easier to discern than angry faces. Our results are in line with several other studies that found more self-reported impulsivity in adolescents (Glenn & Klonsky, 2010; Janis and Nock, 2009) or adults with SIB (McCloskey et al., 2012), but lacked to show this difference on behavioral measures. However, this discrepancy is not solely observed in adolescents with NSSI, but represents a general difficulty in the measurement of impulsivity which may be explained by the measurement of different impulsivity constructs (Mc Closkey et al., 2012). It remains to be clarified, if the difference between self-reported and experimentally assessed impulsivity can be explained by the measurement of different impulsivity constructs (Mc Closkey et al., 2012), or if adolescents with NSSI are able to suppress their impulsivity for an experimental task. Adolescents with NSSI+BPD reported even more impulsivity than adolescents with NSSI-BPD, especially more non-planning impulsivity (lack of future orientation and foresight). Highly impulsive individuals may be especially motivated to act rashly in the context of negative emotions because long-term benefits become less important than short-term gains of emotion regulation (e.g., The Theory of Urgency, Cyders & Smith, 2008; also see Tice, Bratslavsky, & Baumeister, 2001). Therefore, individuals with high levels of non-planning impulsivity 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. However, there was no significant difference between adolescents with NSSI+BPD and with NSSI-BPD in the Go / No Go task.

The results of the present study should be interpreted in the context of some limitations. The design of the study was cross-sectional. Therefore, the current study cannot explain if certain personality traits might favor the development of NSSI. This has to be investigated in future prospective longitudinal studies. Nevertheless, results indicate an association between personality traits and NSSI disorder. Further studies should include equally distributed samples of adolescents with NSSI+BPD and NSSI-BPD. But despite the

small NSSI+BPD sample size in this study, significant differences emerged between NSSI+BPD and NSSI-BPD. The relatively small number of clinical control adolescents can be explained by the high prevalence rates of NSSI (30-61%) in inpatient samples (Kaess et al., 2013; Nock & Prinstein, 2004). Our sample consisted of female adolescents admitted to a psychiatric unit and therefore generalizations to other samples must be made with caution. A further limitation is the use self-report measures, only for one aspect of novelty seeking, impulsivity, an experiment was conducted. Considering the low error rate, the Go/No Go task used to assess impulsivity might have been too simple. Future studies should use less intense emotional facial expressions (< 100%) and a higher Go stimuli to No Go stimuli ratio to increase the respond pressure.

Strengths of this study were the use of the *DSM-5* diagnostic criteria for NSSI disorder in a clinical sample. In addition, a clinical control group of adolescents with other mental disorders without NSSI were included. This allowed us to identify personality traits specific to NSSI disorder. To our knowledge, this is the first study to compare personality traits in adolescents with NSSI+BPD and adolescents with NSSI-BPD in an inpatient setting.

Given the differences in personality traits between adolescents with NSSI+BPD and adolescents with NSSI-BPD a personality assessment using the JTICI (Goth & Schmeck, 2009) might be useful for the diagnostic distinction between adolescents with NSSI with and without BPD. A clear distinction of these two groups might help choosing a specific treatment and the adequate treatment intensity for adolescents engaging in NSSI. So far, there is a lack of specific treatment programs for adolescents with NSSI. As we found adolescents with NSSI to be significantly less impaired in personality functioning and to experience less internalizing and externalizing symptomatology (In Albon et al., 2013) than adolescents with BPD, they might need a lower intensity of treatment sessions than the common treatments for

BPD (e.g., Dialectical Behavioural Therapy; Linehan, 1993). Therefore, the development of specific treatment programs may not only optimize treatment, but also reduce treatment costs.

The prognostic significance of personality for the development of NSSI and BPD has to be further examined in longitudinal studies. If confirmed, the assessment of personality traits could help to identify adolescents at high risk for the development of NSSI. This would allow indicated specific prevention programs. The need to develop more effective and targeted prevention and intervention initiatives for personality disorders was highlighted by Grant et al. (2004). Similarly the identification of adolescent with NSSI at high risk for the development of a BPD could help to get them into specific treatments. Different studies showed that early intervention with specific treatments prevents chronicity (Zanarini et al. 2006, Chanen et al. 2008). Especially, Cloninger's character traits (self-directedness, cooperativeness, and self-transcendence) offer a basis for resource-oriented interventions. So far, there are no psychological programs promoting character development in accordance to Cloninger's personality model (1987), but an existing program focuses on similar aspects, for example problem-solving or conflict resolution (Witt et al., 2014). Future studies should investigate the long-term influence of psychotherapy on character and temperament traits and the possibility to improve quality of life and reduce psychopathology through personality changes. In the longer term there is a need for research specific interventions with additive designs, tailored to individual deficits.

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Table 1

Temperament and character dimensions (Cloninger, 1999)

	Dimension	High level	Low level
Temperament	Novelty Seeking	Curious, impulsive, sensation seeking	Indifferent, thoughtful, modest
	Harm Avoidance	Worried, pessimistic, frightened, shy	Relaxed, optimistic, fearless, confident, talkative
	Reward dependence	Sensitive, warm, dependent	Cold, secluded, independent
	Persistence	Hard-working, ambitious, perfectionist	Inactive, lethargic, pragmatic
Character	Self-directedness	Mature, effective, responsible, determined, high self-acceptance	Immature, unreliable, indecisive, low self- acceptance
	Cooperativeness	Social tolerant, empathic, helpful	Social intolerant, critical, cold, not helpful, destructive
	Self- transcendence	Experienced, patient, creative, self-forgetting, connected to the universe, spiritual	Uncomprehending, proud, unimaginative, lack of humility,

Table 2

Mean (standard deviations) of characteristics of non-clinical adolescents (NC), clinical controls without NSSI (CC), adolescents with NSSI disorder (NSSI), and adolescents with NSSI and BPD (NSSI+BPD), as well as ANOVA with orthogonal contrasts and effect sizes (Cohen's *d*) between non-clinical and clinical groups (NC vs. rest), clinical controls and NSSI (CC vs. NSSI and NSSI+BPD), and NSSI disorder vs. Borderline personality disorder (NSSI vs. NSSI+BPD).

Characteristic	NC <i>M</i> (<i>SD</i>)	CC <i>M</i> (<i>SD</i>)	NSSI <i>M</i> (<i>SD</i>)	NSSI+BPD <i>M</i> (<i>SD</i>)	NC vs. rest <i>t</i> (<i>n</i>)	Cohen's <i>d</i>	CC vs. NSSI total	Cohen's <i>d</i>	NSSI vs. NSSI+BPD	Cohen's <i>d</i>
YSR total	(<i>n</i> = 57) 57.60 (18.70)	(<i>n</i> = 28) 81.80 (21.60)	(<i>n</i> = 47) 105.38 (29.97)	(<i>n</i> = 11) 134.28 (22.40)	<i>t</i> (139) 12.56**	2.22	<i>t</i> (139) 7.04**	1.55	<i>t</i> (139) 4.03**	1.02
YSR ext ¹	9.79 (6.56)	12.38 (6.45)	17.47 (9.15)	30.76 (7.82)	6.77**	1.43	4.58**	1.51	3.50**	1.52
YSR int	9.83 (6.46)	23.68 (9.56)	32.49 (9.53)	41.18 (8.68)	14.66**	2.76	6.22**	1.44	3.10**	0.94
BDI ²	7.02 (7.20)	21.89 (12.68)	33.40 (12.17)	43.20 (13.29)	13.17**	2.39	4.70**	1.31	1.82	0.81
JTCI	(<i>n</i> = 51)	(<i>n</i> = 26)	(<i>n</i> = 46)	(<i>n</i> = 11)	<i>t</i> (130)		<i>t</i> (130)		<i>t</i> (130)	
Novelty seeking (T) ¹	47.29 (8.20)	43.00 (8.62)	48.20 (11.61)	56.00 (8.31)	0.66	0.20	3.42**	0,96	2.39*	0.72
Harm avoidance (T)	49.33 (10.18)	59.38 (8.59)	61.35 (11.10)	69.64 (8.51)	7.32**	1.47	2.34*	0,66	2.44*	0.79
Reward dependence (T)	57.06 (8.37)	52.04 (9.20)	49.96 (10.77)	45.91 (12.03)	-4.18**	0.79	-1.64	0,39	-1.24	0.37
Persistence (T)	50.22 (10.21)	53.73 (9.93)	45.09 (11.74)	35.27 (9.70)	-2.71**	0.54	-4.92**	1.31	-2.74**	0.88
Self-directedness (C)	52.22 (10.41)	43.88 (10.45)	33.22 (11.70)	26.73 (9.81)	-8.51**	1.68	-4.97**	1.32	- 1.78	0.58
Cooperativeness (C)	53.75 (8.89)	56.88 (9.21)	54.93 (11.77)	46.27 (9.70)	-0.54	0.11	-2.41*	0.62	-2.56*	0.78
Self-transcendence (C)	49.43 (9.58)	53.92 (10.68)	50.02 (9.12)	50.82 (11.81)	1.15	0.21	-1.38	0.34	0.24	0.08
Impulsivity (BIS)	(<i>n</i> =28) 20.76 (3.15)	(<i>n</i> =21) 20.06 (3.47)	(<i>n</i> =29) 22.97 (3.94)	(<i>n</i> =8) 26.85 (2.78)	<i>t</i> (82) 2.99**	0.77	<i>t</i> (82) 4.70**	1.45	<i>t</i> (82) 2.78**	1.07
Attentional	15.61 (4.01)	14.90 (3.16)	18.25 (4.10)	20.88 (1.89)	2.67**	0.72	4.34**	1.55	1.77	0.72
Nonplanning	25.52 (4.33)	24.59 (5.13)	27.47 (5.76)	34.63 (5.07)	2.72**	0.68	4.27**	1.24	3.51**	1.31
Motor	21.16 (3.96)	20.70 (3.97)	23.21 (6.90)	25.04 (4.04)	1.46	0.39	2.24*	0.70	0.89	0.29

Note. YSR = Youth self report (ext = externalizing, int = internalizing), BDI = Beck Depression Inventory-II; JTCI = Junior Temperament and Character Inventory; BIS = Barratt Impulsiveness Scale. **p* < 0.05, ***p* < 0.01. ¹log transformation, ²root transformation.

Table 3

Sensitivity index d' , commission and omission errors of the Go/No Go, as well as reaction times for go trials of non-clinical adolescents (NC), clinical controls without NSSI (CC), adolescents with NSSI disorder (NSSI), and adolescents with NSSI and borderline personality disorder (NSSI+BPD).

Condition		NC	CC	NSSI	NSSI+BPD
		<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
<i>d'</i>	X	0.16 (1.16)	0.31 (1.07)	-0.01 (1.30)	-0.27 (1.29)
	Angry Go (Neutral No Go)	0.12 (1.66)	-0.18 (1.59)	0.02 (1.38)	-0.72 (1.46)
	Happy Go (Neutral No Go)	-0.04 (1.47)	0.42 (0.87)	0.08 (1.37)	-0.86 (1.50)
	Neutral Go (Angry No Go)	0.05 (1.12)	0.19 (1.19)	-0.10 (1.33)	-0.40 (1.50)
	Neutral Go (Happy No Go)	0.34 (1.44)	0.36 (0.82)	0.06 (1.46)	-0.62 (1.20)
Commission	X	1.95 (4.55)	2.00 (5.19)	2.02 (4.57)	3.57 (7.45)
	Angry Go (Neutral No Go)	15.42 (14.80)	15.42 (11.22)	18.63 (16.92)	21.15 (16.44)
	Happy Go (Neutral No Go)	8.67 (11.43)	6.67 (10.24)	8.82 (11.80)	13.39 (11.46)
	Neutral Go (Angry No Go)	5.83 (9.34)	4.03 (9.89)	6.37 (9.37)	4.46 (9.31)
	Neutral Go (Happy No Go)	5.42 (10.88)	3.23 (6.43)	5.19 (9.31)	6.25 (9.49)
Omission	X	14.34 (13.24)	12.26 (13.09)	17.21 (15.13)	18.57 (10.46)
	Angry Go (Neutral No Go)	7.38 (12.37)	10.48 (12.95)	6.37 (6.76)	11.61 (10.36)
	Happy Go (Neutral No Go)	0.82 (3.12)	0.00 (0.00)	0.47 (2.40)	1.79 (4.54)
	Neutral Go (Angry No Go)	2.29 (6.71)	2.92 (5.38)	3.54 (9.61)	8.65 (9.39)
	Neutral Go (Happy No Go)	4.30 (16.44)	6.05 (18.78)	6.60 (18.61)	12.50 (18.99)
RT Go	X	373.62 (42.10)	378.22 (41.96)	361.03 (40.66)	353.66 (29.87)
	Angry Go (Neutral No Go)	514.52 (86.87)	529.93 (109.17)	509.37 (83.11)	421.31 (119.90)
	Happy Go (Neutral No Go)	483.46 (72.24)	492.22 (81.30)	478.21 (78.84)	487.61 (96.52)
	Neutral Go (Angry No Go)	503.67 (86.93)	522.27 (89.08)	516.01 (82.00)	517.93 (100.72)
	Neutral Go (Happy No Go)	533.06 (87.16)	546.78 (106.83)	527.60 (95.38)	551.99 (89.60)

Note. d' = sensitivity index; Commission = Commission error; Omission = Omission error, RT Go = reaction time for the go condition. There were no significant group effects.

Facial emotion recognition in adolescents with nonsuicidal self-injury

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Abstract

Adolescents with nonsuicidal self-injury (NSSI) have been described as having considerable impairment in social interactions, and social difficulties are often a trigger for NSSI. However, little is known about how adolescents with NSSI disorder process facial expressions of emotion. We investigated the recognition of facial expressions of emotion in 47 adolescents with NSSI disorder, 28 clinical controls without NSSI, and 51 nonclinical controls. Following a neutral or a sad mood induction, participants were presented with a dynamic facial expression that slowly changed from neutral to full-intensity happiness, sadness, anger, disgust, fear or neutral (closed/open mouth). Recognition of facial expressions was measured by the intensity of the expression at which participants could accurately identify the facial expression. No group differences in the recognition of facial expressions were found. All groups required comparable stages of emotional expressivity to correctly recognize emotions, and there were no significant differences in accuracy. Results indicate no mood effect on recognition or accuracy. Valence and arousal ratings of stimuli indicated that compared to the nonclinical control group but not to clinical controls, the adolescents with NSSI disorder rated the stimuli as significantly more unpleasant and arousing.

Keywords: nonsuicidal self-injury, adolescence, *DSM-5*, mood induction, emotion identification, morphing

1. Introduction

Nonsuicidal self-injury (NSSI) disorder is defined as repetitive, intentional, self-inflicted damage to the surface of a person's body without suicidal intent and for other than socially accepted reasons (Lloyd-Richardson et al., 2007; American Psychiatric Association, 2013). It affects 4–6% of adolescents (Muehlenkamp et al., 2012; Zetterqvist et al., 2013) and over 40% of inpatient adolescents (Glenn and Klonsky, 2013; Kaess et al., 2013). Adolescents with NSSI disorder are often seen with high rates of comorbidity, low functioning, and difficulties in emotion regulation (In-Albon et al., 2013; Bresin, 2014), and NSSI behavior is a major risk factor for suicidality (Klonsky et al., 2013; Tuisku et al., 2014).

Frequently, NSSI serves multiple functions simultaneously (Klonsky, 2007). Intrapersonal factors, especially regulating negative emotions, are most frequently reported by adolescents with NSSI behavior or disorder, followed by the need to feel something even if it is pain (e.g. Nock and Cha, 2009; In-Albon et al., 2013; Zetterqvist et al., 2013). Interpersonal functions refer to performing NSSI to communicate with, influence, and connect with others, particularly when less extreme attempts at communication fail to produce results (Nock, 2008). The behavioral models further propose that social functions perpetuate NSSI through positive reinforcement (e.g., obtaining personal resources) and negative reinforcement (e.g., avoiding interpersonal demands; Nock and Cha, 2009). Self-report studies indicated high relevance of interpersonal functions for patients with NSSI behavior (Nock and Prinstein, 2004; Lloyd-Richardson et al., 2007; Baetens et al., 2011) and social interaction problems are often a trigger for NSSI (Nock and Mendes, 2008). Although social functions may play a smaller role than affect regulation, they are prevalent and seem especially important for initiating NSSI (Muehlenkamp et al., 2013). Primarily, NSSI is therefore used as a maladaptive coping strategy for intense emotions resulting from intra- and interpersonal difficulties (Nock, 2010).

There is a link between emotion recognition and emotion regulation. Yoo et al. (2006)

concluded that emotion recognition is a precursor to emotion regulation, in the sense that if emotion is not recognized, in self and others, there is nothing to regulate. If emotional facial expressions are not recognized correctly, emotion regulation will be influenced. Facial emotion perception is a central feature of intact social functioning. Facial expressions typically contain cues of different emotion categories and thus are intrinsically ambiguous (Matsumoto and Imamura, 2008). The ability to accurately infer facial emotional expressions is highly essential for guiding one's own behavior and regulating one's own emotional state in social contexts. Marsh et al. (2007) indicated that the ability to recognize fear facial expressions predicts prosocial behavior. Misinterpretations due to dysfunction in perception are likely to result in emotional disturbances, inadequate social behavior, lack of social skills, and less adaptive social problem-solving skills, problems often observed in adolescents with NSSI behavior (Nock and Mendes, 2008; Claes et al., 2010). Thus, social, emotional, and problem-solving skills include identifying emotions in others. To our knowledge, there is no study on emotion recognition abilities in adolescents with NSSI. As some adolescents with NSSI meet the criteria for borderline personality disorder (BPD), in the following, we will refer to morphing studies with subjects with BPD. In adolescents with BPD, results on emotion recognition are inconsistent. Von Ceumern-Lindenstjerna et al. (2007) asked female adolescents with BPD to name the displayed emotion by using a self-report questionnaire on the perception of emotions in facial expressions. Results indicated no deficits in naming the displayed emotions. Jovev et al. (2011) described no differences in emotional sensitivity in adolescents with subsyndromic features of BPD compared to healthy controls, yet Robin et al. (2012) investigated adolescents with BPD and showed a lower sensitivity to facial emotions of anger and happiness, but no impairment in identifying fully expressed emotions. Both studies used dynamic facial expressions; however, they used the adult, black-and-white Ekman and Friesen (1976) pictures. Results of studies with adult participants with BPD are also inconsistent. Lynch et al. (2006) reported a greater sensitivity to facial expressions,

whereas Domes et al. (2008) reported no differences. See also Domes et al. (2009) and Mitchell et al. (2014) for a review on emotion recognition in BPD. Mitchell et al. (2014) concluded that despite methodological differences, no significant recognition impairments between BPD and healthy controls for any negative emotion was revealed. As a limitation, the specificity of the findings to BPD has been questioned, as all the studies compared BPD only to healthy controls. The above-mentioned studies recruited adolescents with BPD or BPD features. However, only a minority of patients with NSSI disorder (In-Albon et al., 2013) and adults with NSSI behavior (Selby et al., 2012) meet the criteria for BPD.

Another issue to consider is that the current mood of the subjects influences facial emotion recognition (Mullins and Duke, 2004; Chepenik et al., 2007; Schmid and Schmid Mast, 2010). The information-processing theory proposes that mood affects perception and attention (Dodge, 1991). This has been shown in various studies. For example, Lee et al. (2008) indicated that for participants in a sad mood, their mood had an influence on facial recognition such that they tended to classify ambiguous as negative, and Chepenik et al. (2007) showed that sad mood interfered with facial emotion recognition. However, these studies investigated adults from community samples. Studies with a clinical sample of adolescents examining the effect of a mood induction on emotion recognition are still missing.

The functional approach to understand NSSI has received much attention and support (see Bentley et al., 2014 for a review). Whereas the automatic mechanisms have been widely investigated (Nock, 2010; Klonsky, 2011), social functions are both understudied and underreported in comparison with the automatic functions (Nock, 2008; Bentley et al., 2014). Bentley et al. (2014) suggested that researchers should consider the employment of objective measures (e.g., facial emotion recognition) of specific interpersonal skills in studies on NSSI to investigate observed problems with a range of communication skills in individuals with NSSI. Results may inform preventive and treatment efforts for individuals with NSSI.

In addition to the more objective measure of facial emotion recognition using a morphing paradigm, we obtained a dimensional rating of the facial expressions in terms of valence and arousal. To our knowledge there is no study investigating the valence and arousal of facial expressions in adolescents with NSSI disorder. Therefore, the aim of the present study was to investigate recognition of dynamic emotional facial expressions in a sample of female adolescents with NSSI disorder, a clinical control sample and a nonclinical control sample, to investigate disorder specificity, to consider the influence of a sad and a neutral mood on emotion recognition, and to obtain a dimensional rating of valence and arousal. Given that theoretically, emotion recognition is seen as a precursor to emotion regulation and emotion regulation is impaired in adolescents with NSSI, we hypothesized that adolescents with NSSI have more difficulties recognizing facial expressions, with respect to the mean percentage of stages viewed before the first correct response or in decoding accuracy, that is, in the overall number of emotions recognized. Given the previous inconsistent results on the type of misinterpretation, we did not formulate any firm directional hypotheses with respect to misinterpretations. However, we did predict a decline in emotion recognition, mean percentage of stages before the first correct response, and accuracy when a sad mood was induced compared to a neutral mood.

2. Methods

2.1. Subjects

Subjects were 126 female adolescents, aged 13–19 years, recruited from different inpatient psychiatric units in Switzerland and Germany. Subjects included 47 adolescents who fulfilled the proposed *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013) criteria for NSSI disorder (NSSI group), 28 adolescents with a *DSM-IV* (American Psychiatric Association, 1994) diagnosis other than NSSI (clinical controls, CC group), and 51 nonclinical adolescents who had no current or past experience of mental disorder (nonclinical controls, NC group). Demographic and psychosocial characteristics

of adolescents in the NSSI, CC, and NC groups are reported in Table 1. The most common comorbid diagnosis of the adolescents with NSSI was major depression (33 patients, 70.2%), followed by social phobia (18 patients, 38.3%) and specific phobia (10 patients, 21.3%). Thirteen adolescents fulfilled criteria for BPD and were excluded from the analyses so we could restrict the results to NSSI. The most frequent diagnosis in the CC group was also major depression (10 patients, 35.7%) followed by social phobia (10 patients, 35.7%) and specific phobia (7 patients, 25%). Significantly more patients with NSSI than clinical controls fulfilled the criteria for major depression, $\chi^2(1) = 9.28, p < 0.01$, whereas significantly more clinical controls than patients with NSSI disorder fulfilled the diagnosis obsessive-compulsive disorder, $p < 0.01$, according to a two-sided Fisher's exact test. There were no significant differences regarding any other *DSM-IV* disorders assessed with the clinical interviews. Patients with NSSI met significantly more diagnoses ($M = 3.36, SD = 1.37$) than clinical controls ($M = 2.00, SD = 1.09$), $t(68.00) = 4.74, p < 0.01$. The samples were similar with respect to age, $F(2, 113) = 2.79, p = 0.07$. In the NSSI group 27 adolescents reported current psychotropic medication use, including antidepressants ($n = 15$), antipsychotics ($n = 3$), stimulants ($n = 6$), tranquilizer ($n = 1$), and anticonvulsant ($n = 2$). In the CC group 20 adolescents reported current psychotropic medication use, including antidepressants ($n = 11$), antipsychotics ($n = 6$), stimulants ($n = 1$), tranquilizer ($n = 1$), and anticonvulsants ($n = 1$). In the NC group no psychotropic medication use was reported. A chi-square test indicated no significant difference in the psychotropic medication use between adolescents with NSSI and clinical controls, $\chi^2(1, N = 75) = 0.80, p = 0.37$.

The inpatient clinics were responsible for the recruitment of the clinical groups. Therefore, we have no access to the demographic and clinical characteristics of patients excluded by the clinics. Our predefined exclusion criteria were current or past psychosis, schizophrenic symptoms, and acute substance abuse.

2.2. Diagnostic assessments

To examine current or past *DSM-IV-TR* (American Psychiatric Association, 2000) diagnoses of the participants, we conducted a structured interview (Kinder-DIPS; Schneider et al., 2009) for axis-I disorders. The Kinder-DIPS assesses the most frequent mental disorders in childhood and adolescence (all anxiety disorders, major depression, dysthymia, eating disorders, sleeping disorders, attention deficit hyperactivity disorder, and conduct disorder, as well as substance use disorders from the adult DIPS). The Kinder-DIPS has good validity and reliability for axis I disorders (child version, kappa = 0.48 to 0.88, parent version, kappa = 0.85 to 0.94; Adornetto et al., 2008; Neuschwander et al., 2013). NSSI disorder was assessed using the proposed *DSM-5* criteria (Shaffer and Jacobson, 2009) and with the publication of the *DSM-5* all NSSI diagnoses were reevaluated. The criteria were reformulated as questions and added to the interview. Interrater reliability estimates for the diagnosis of NSSI were very good (kappa = 0.90). The SKID-II (Wittchen et al., 1997) for personality disorders was conducted. Interrater reliability for BPD in our sample was very good (kappa = 1.00). Before conducting the interviews all interviewers received an intensive standardized training.

2.2.1. Measures

The Youth Self-Report (YSR, Achenbach, 1991; Döpfner et al., 1994) measures a broad range of psychopathology. Internal consistency in the present sample was $\alpha = 0.96$ for the total score, $\alpha = 0.94$ for the internalizing score, and $\alpha = 0.90$ for the externalizing score.

The Beck Depression Inventory-II (BDI-II, Hautzinger et al., 2006) consists of 21 items and assesses depressive symptoms in adolescents. The internal consistency in the present sample was $\alpha = 0.96$.

The Borderline Symptom List (BSL-95; Bohus et al., 2007) is a self-rating instrument for specific assessment of borderline-typical symptomatology. The BSL-95 includes 95 items. The internal consistency within the present sample for the total score was $\alpha = 0.98$.

2.3. Facial morphing task

Stimuli. The set of 60 faces was generated from the NimStim Face Stimulus Set (www.macbrain.org). The images contained happy, sad, angry, disgusted, fearful, and neutral expressions of 10 individuals (5 female, 5 male). The color images were evaluated by young adults (Tottenham et al., 2009). In addition, in a pilot study, we investigated 77 facial stimuli in 256 adolescents between 14 and 17 years of age. Results were similar to those of the original Tottenham et al. (2009) study. The mean percentage of correctly identified emotions was 80.79%. Happiness was identified best with 96.3%, and fear worst with 71.61%.

Design. We used the morphing technique from WinMorph 3.01 (www.debugmode.com/winmorph) to create 50 unique faces that changed in 2% steps from neutral to full emotion. Another 10 faces remained neutral but were manipulated to display small movements (opening and closing the mouth; the NimStim faces consist of neutral pictures with an open and a closed mouth). Each facial picture was presented for 100 ms using E-Prime software (Psychology Software Tools, Pittsburgh, Penn.), which creates the impression of an animated clip of the progression of an emotional facial expression. All six expressions (happiness, sadness, anger, disgust, fear, neutral) were shown in each of seven trials, resulting in 42 sequences. The presentation of the pictures was randomized. Before each facial stimulus a fixation cross was shown for 500 ms. The sequences were shown in two blocks that were followed by a neutral and a negative mood induction (in randomized order). Each block consisted of 30 facial stimuli (6 emotions \times 5 models). Subjects were instructed to watch the face change from neutral to an emotion and to press the space bar as soon as they recognized an emotion. After the participants pressed the space bar, the sequence stopped and they were presented with a rating screen asking them to identify the emotion as happiness, sadness, anger, disgust, fear, or neutral. The intensity of the emotion being expressed on the face when the participants pressed the space bar was recorded. Valence and arousal were assessed after each facial stimulus. Each participant participated in the task after a neutral and after a negative mood induction (in randomized order). Practice trials with all emotions were

conducted.

2.4. Mood induction

Film clips are effective at inducing emotions (Silverman, 1986; Westermann et al., 1996). Before completing the morphing paradigm, participants were shown in random order a brief sad or neutral film clip to induce a negative or neutral mood state. Sadness is a common emotion in adolescents with NSSI and a predictor of the urge to engage in NSSI (Bresin et al., 2013). Therefore, a sad mood induction was chosen. *My Girl* (Zeiff, 1991) depicts a girl learning that her best friend has died and was used for the negative mood induction. For the neutral mood induction part of a documentary on stars was shown. Both clips have shown their efficacy in mood induction (Bolten and Schneider, 2010; Joormann et al., 2010). Following the film clip, participants were asked to think about how they would feel if they experienced the situation they had just viewed. Before and after the mood induction, the present mood (sadness, happiness) was assessed on a 7-point Likert scale.

2.5. Ratings of facial expressions' valence and arousal

After the mood induction, each adolescent rated the set of 60 facial expressions with regard to their valence and arousal using the Self-Assessment Manikin, a pictorial 9-point scale (Bradley and Lang, 1994) ranging for valence from 1 (*very pleasant*) to 9 (*very unpleasant*), and for arousal from 1 (*very excited*) to 9 (*very calm*).

2.6. Procedure

All participants and their parents were informed about the study and provided their informed written consent in accordance with the Declaration of Helsinki. The local ethics committees approved the study. The diagnostic interviews and questionnaires were completed prior to commencing the experimental task. Participants were paid 40 Swiss francs upon completion of the tasks.

2.7. Data analysis

The intensity scores of the facial expression at the time of the space bar press were analyzed with a 3 (Group: NSSI, CC, NC) \times 6 (Emotion: happiness, sadness, anger, disgust, fear, neutral) \times 2 (Mood: neutral, sad) repeated-measures analysis of variance (ANOVA) with group as between-subjects factor and emotion and mood as within-subject factors. The Greenhouse–Geisser correction was applied in the case of inhomogeneity of variance. Similarly, analyses were conducted for group differences in the accuracy of emotion recognition and the valence and arousal ratings of the stimuli. Post hoc Bonferroni-corrected contrasts were computed to assess the direction of the differences.

3. Results

3.1. Manipulation check of mood induction

To ensure effectiveness of the mood induction, we conducted a Group (NSSI, CC, NC) \times Time (before, after mood induction) repeated-measures ANOVA on self-reported mood (sadness, happiness) for both film clips. As expected, this analysis yielded a significant main effect of time for the sad film clip, $F(1, 121) = 26.00, p < 0.01$. All participants endorsed more sadness after watching the *My Girl* film clip ($M = 3.68, SD = 1.82$) than before ($M = 2.19, SD = 1.68$), $d = 0.85$. There was no main effect of group, $F(2, 121) = 1.46, p = 0.23$, and no Group \times Time interaction, $F(2, 121) = 1.90, p = 0.15$. For the neutral film clip, the analysis yielded, a nonsignificant main effect of group, $F(2, 121) = 0.88, p = 0.42$, and no Group \times Time interaction, $F(2, 121) = 0.26, p = 0.77$. However, the main effect of time was significant $F(1, 121) = 5.45, p = 0.02$, indicating a decrease in emotion intensity for sadness and happiness.

3.2. Facial emotion recognition

The mean percentage of stages until the first correct response for each of the target emotions and for the three groups after sad and neutral mood induction are displayed in Table 2. For the recognition threshold of the facial expression, we conducted a 3 (Group: NSSI, CC, NC) \times 2 (Mood: neutral, sad) \times 6 (Emotion: happiness, sadness, anger, disgust, fear, neutral)

repeated-measures ANOVA. Results yielded a nonsignificant three-way interaction, $F(8.35, 492.661) = 1.49, p = 1.52, \eta_p^2 = 0.02$. Neither the main effect of group, $F(2, 118) = 1.04, p = 0.35, \eta_p^2 = 0.01$, nor the main effect of mood, $F(1, 118) = 0.99, p = 0.32, \eta_p^2 = 0.01$, was statistically significant. The main effect of emotion was significant, $F(2.59, 305.85) = 64.77, p < 0.01, \eta_p^2 = 0.35$. In particular, happiness was identified significantly earlier than the other emotions in all groups, $F(1, 118) = 486.41, p < 0.01, \eta_p^2 = 0.81$, and sadness was identified significantly later than the other emotions in all groups, $F(1, 118) = 193.81, p < 0.01, \eta_p^2 = 0.62$.

To examine whether emotion recognition in the NSSI group was associated with differences in the use of psychotropic medication, a t-test was conducted. Therefore, the mean percentage of stages until the first correct response was examined as a function of medication usage. Across emotion categories, there was a significant difference between adolescents with NSSI with psychotropic medications ($n = 26, M = 79.77, SD = 7.99$) and without medications ($n = 18, M = 73.68, SD = 8.15$), $t(42) = -2.47, p = 0.02, d = 0.75$, indicating that adolescents without psychotropic medication correctly identified facial expressions earlier than medicated adolescents NSSI. These two groups did not significantly differ on the YSR total score, $t(38) = -0.82, p = 0.42$.

3.3. Accuracy of emotion recognition

The percentages of correctly recognized emotional facial expressions after sad and neutral mood induction in the three groups are presented in Table 3. For the accuracy of emotion recognition, the 3 (Group: NSSI, CC, NC) \times 2 (Mood: neutral, sad) \times 6 (Emotion: happiness, sadness, anger, disgust, fear, neutral) repeated-measures ANOVA yielded a nonsignificant three-way interaction $F(8.67, 511.45) = 0.39, p = 0.93, \eta_p^2 = 0.007$. Neither the main effect of group, $F(2, 118) = 0.65, p = 0.52, \eta_p^2 = 0.01$, nor of mood, $F(1, 118) = .015, p = 0.69, \eta_p^2 = 0.001$ was statistically significant. Across all the emotions, the fewest errors were made for recognizing happy facial emotions, $F(1, 118) = 743.93, p < 0.01, \eta_p^2 = 0.86$. The

most errors were made identifying neutral facial expressions, $F(1, 118) = 74.24, p < 0.01, \eta_p^2 = 0.38$ followed by fearful facial expressions, $F(1, 118) = 24.88, p < 0.01, \eta_p^2 = 0.17$.

Incorrect responses of neutral and fearful facial expressions are presented in Table 4. As can be seen in Table 4, neutral facial expressions were significantly more often identified as fearful expressions, $F(1, 118) = 164.55, p < 0.01$, and fearful expressions were significantly more often identified as disgusted expressions, $F(1, 118) = 94.49, p < 0.01$.

3.4. Ratings of stimulus valence and arousal

Group means and standard deviations of valence and arousal ratings for the correctly recognized stimuli are presented in Table 5. Valence and arousal ratings indicated that the stimuli elicited different emotional responses in the three groups. The main effect of group was significant for arousal, $F(2, 123) = 5.64, p < 0.01, \eta_p^2 = 0.08$, and valence, $F(2, 123) = 5.1, p < 0.01, \eta_p^2 = 0.07$. As can be seen in Table 5, all groups rated the valence of happy facial expressions as significantly more pleasant compared to the other emotions, $M = 3.85$ ($SD = 0.14$), $p < 0.01$, and anger as most unpleasant, $M = 5.41$ ($SD = 0.14$), $p < 0.01$. In addition, there was a significant main effect of emotion for arousal, $F(2.85, 347.50) = 9.1, p < 0.01, \eta_p^2 = 0.07$, and for valence, $F(3.16, 389.21) = 50.84, p < 0.01, \eta_p^2 = 0.29$. Post hoc Bonferroni-corrected contrasts indicated a significant difference, in that adolescents with NSSI rated the stimuli as more unpleasant ($p = 0.01$) and arousing ($p < 0.01$) than nonclinical adolescents. The contrasts between adolescents with NSSI and the clinical control group were not significant for arousal ($p = 1.00$) or valence ($p = 1.00$). The contrasts between clinical controls and nonclinical controls were just not significant for arousal ($p = 0.06$) and valence ($p = 0.059$). Valence and arousal were assessed after both film clips; however, similar to the results for emotion recognition, mood had no significant effect on arousal, $F(1, 123) = 0.53, p = 0.46, \eta_p^2 = 0.004$, or on valence, $F(1, 123) = 1.02, p = 0.31, \eta_p^2 = 0.17$.

Including psychopathology assessed with the YSR total score as a covariate in the analyses, the main effect of group was significant for arousal, $F(2, 99) = 5.40, p = 0.01, \eta_p^2 =$

0.1, but not significant for valence, $F(2, 99) = 2.61, p = 0.08, \eta_p^2 = 0.05$. There was a significant main effect for valence, $F(3.27, 323.65) = 4.53, p < 0.01, \eta_p^2 = 0.04$, but no significant main effect of emotion for arousal, $F(3.16, 312.66) = 0.66, p = 0.59, \eta_p^2 = 0.19$.

4. Discussion

The present study investigated if adolescents with NSSI compared to adolescents with mental disorders without NSSI and adolescents without mental disorders differed in their capacity and accuracy in recognizing emotions in dynamic facial expressions following a negative and neutral mood induction. The results of this study indicate that adolescents with NSSI have no general deficits in accurately recognizing emotional facial expressions assessed with a morphing paradigm. There were no group differences in the intensity of emotion required for participants to correctly identify happy, sad, angry, disgusted, fearful, or neutral facial expressions. In addition, there were also no group differences in the accuracy of emotion recognition. For neutral facial expressions no bias effect was found; all three groups mostly perceived the neutral expressions as fearful expressions.

In the present study, in the NSSI group a significant effect of psychotropic medications was found on the first correct response of the stimuli that with medications the adolescents with NSSI required significantly more stages to correctly recognize the stimuli compared to adolescents with NSSI without medications. In the study by Domes et al. (2008) no effect of medication on detection threshold and accuracy was found in adults with BPD and in the study by Lynch et al. (2006) also with adult patients with BPD although the effect of medication on emotion recognition was non significant, there was a medium effect size that unmedicated participants with BPD correctly identified facial emotion slightly earlier than medicated participants with BPD. However, our results are consistent with Coupland et al. (2003) found a significant effect of diazepam on the recognition of emotional expressions and in recognition accuracy. As there was no difference between the adolescents with NSSI with and without psychotropic medications on the YSR total score, other variables might be

responsible for the difference indicating that the effect of medications has further to be investigated as Mitchell et al. (2014) stated in their review on facial emotion processing that medication and psychological treatment status is rarely considered. However, the influence of medication, especially of different pharmacological therapeutic strategies, on the capacity to correctly recognize and decode emotions has a relevance to explain additive effects of the combination of pharmacological and psychotherapeutic interventions or vice versa on the absence of additive effects. These interactions might be an explanation to the limited body of knowledge among evidence based pharmacological treatment options in patients with NSSI (Plener and Libal, 2014).

Nock's integrated theoretical model (2009, 2010) postulates a vicious circle such that for the development of NSSI predisposing factors, stressful events, and NSSI-specific factors are necessary. For the maintenance of NSSI, self-injury functions as an immediately effective method of regulating one's emotional experience or influencing one's social environment in a desired way. Our results might indicate that adolescents with NSSI in general possess basic social skills, such as facial emotion recognition, even when they are experiencing moderately sad mood. However, the question remains if these skills can be used in stressful situations and in situations with specific triggers. Due to the good, but also limited ecological validity of morphing paradigms it is important to develop research methods to investigate specifics of emotional recognition in more or less stressful or difficult interpersonal interactions.

Therefore, further research on emotion regulation should focus on difficult social interactions.

Due to the lack of studies with adolescents with NSSI, we have relied on studies investigating adolescents with BPD or borderline personality symptoms to discuss our results. However, caution is warranted when comparing these groups, as several studies have indicated differences between patients with NSSI and those with BPD (Glenn and Klonsky, 2013; In-Albon et al., 2013; Bracken-Minor et al., 2014). Jovev et al. (2011) found that in a facial morphing task, youth with borderline personality symptoms and controls required

comparable levels of emotional detection to correctly identify emotions, results consistent with our own, and the two groups also showed no evidence of heightened sensitivity, that is, the ability to recognize emotion at lower levels of intensity. Jovev et al. (2011) suggested that emotional sensitivity is present only in severe BPD or develops later in the course of the disorder, possibly through continuing exposure to traumatic life events and recurrent mental disorders (Jovev and Jackson, 2006). Support for the explanation that emotional sensitivity might be present only in severe BPD is somewhat lessened, as the present subjects with NSSI were highly impaired with a mean of 3.36 diagnoses and a mean time using NSSI of 4 years. In adolescents with BPD, Robin et al. (2012) found no impairment in identifying fully expressed emotions, but in contrast to our results, they found higher recognition thresholds for facial expressions of anger and happiness than in controls. In adults with BPD results are inconsistent, as well (see also Mitchell et al., 2014 for a meta-analysis). Domes et al. (2008) found no general deficit in their affect recognition tasks. For ambiguous emotional stimuli, they found a bias toward the perception of anger. Yet Lynch et al. (2006) found that adults with BPD correctly identified facial affect at an earlier stage than did healthy controls, regardless of the valence of the expressed emotion. Methodological differences might explain the discrepant results of the Lynch et al. (2006) study, as participants could change their responses as often as they wanted until the end of the expression. In all other studies, each trial was stopped following the first response, which could not be altered. Some differences exist in the procedures of the emotion recognition tasks in the various studies; in the studies by Jovev et al. (2011) and Domes et al. (2008), faces were morphed in 5% steps, compared to 2.5% steps in Robin et al. (2012) and 2% steps in the present study. Therefore, the presentation steps of the facial expressions cannot explain the differences in study results. All except the present study used the adult black-and-white Ekman and Friesen (1976) pictures. At the current state of research, the inconsistent emotion recognition findings cannot be adequately explained because of differences in methods or different clinical samples, as

previous studies did not include a clinical control group. Clearly, more research is needed that investigates different clinical samples with different, validated methods and stimuli.

Neutral facial expressions were not interpreted more often as negative. Neutral facial expressions were also shown dynamically, morphing from a neutral expression with closed mouth to a neutral expression with a slightly open mouth and back to the closed mouth (as the NimStim data set consists of emotional facial expressions with both closed and open mouths). There is only one other study that presented neutral facial expressions to adolescents with BPD; von Ceumern-Lindenstjerna et al. (2007) presented neutral facial pictures on paper. Similar to our findings, their results indicated no dysfunctional interpretation of neutral expressions.

Sad mood had no significant effect on the results, neither for facial emotion recognition nor for accuracy, even though, and in line with results of previous studies (Bolten and Schneider, 2010; Joormann et al., 2010), mood induction was successful and participants endorsed more sadness after watching the negative film clip and showed a decrease in mood intensity after watching the neutral film clip. In contrast, Schmid and Schmid Mast (2010) found a negative bias for participants in a sad mood and a positive bias for participants in a happy mood, and Moody et al. (2007) found that fear induction increased attribution of fear to angry faces. However, as far as we are aware, our study is the first to investigate the influence of mood induction on emotional facial recognition in clinical samples. Further research on mood influences is certainly necessary, especially to describe the specific influence of mood induction with various emotions on different emotions.

Regarding the valence and arousal ratings, adolescents with NSSI rated the neutral and happy facial expressions as more unpleasant and the angry, sad, and happy facial expressions as more arousing than the nonclinical control group. Similarly, Jovev and colleagues (2011) also found that youth with borderline symptoms rated happy emotions as less positive compared to a community group and in female adolescents with BPD, however, they did not

control for psychopathology. Controlling for psychopathology the present results indicated that higher psychopathology has an influence on valence and arousal ratings, however for arousal there was still a significant main effect of group and a borderline main effect of group for valence. Von Ceumern-Lindenstjerna et al. (2007) found that positive facial expressions were rated as more negative compared to healthy controls. The negativity of positive facial expressions was influenced by actual mood and depressive symptoms, but not the trend to interpret positive facial expressions as negative. Therefore, the role of the actual mood and psychopathology has clearly to be investigated in further studies. These results indicate that although adolescents with NSSI adequately recognize the emotion happiness, they interpret the positive emotional expression as more unpleasant and more arousing. The information processing of positive emotions and its role in emotion regulation should be investigated in future studies, especially regarding the specificity to NSSI disorder, as we found no significant difference between adolescents with NSSI and the clinical controls, and previous studies did not include a clinical control group.

Clinical implications for adolescents with NSSI include the need for awareness of the emotion regulation of not only negative but also positive emotions. Von Ceumern-Lindenstjerna et al. (2007) suggested sensitizing patients to the perception of positive stimuli and the experience of positive emotions.

If replicated, our finding that adolescents with NSSI have no deficits in emotion recognition could mean that in treatment, a focus on emotion recognition is not strictly necessary. As mentioned before, the ability to correctly identify facial emotion stimuli should be confirmed, for example, in everyday social interactions or in stressful situations and in situations with specific triggers. Furthermore, although adolescents with NSSI do not have difficulties recognizing facial emotions in others, we do not yet know how well they recognize their own emotions or how they react to emotional facial expressions. The correct identification of one's own emotions might be a crucial step in emotion regulation. If

replicated, our results indicate that the difficulties adolescents with NSSI endorse in social relationships are not likely to be the result of an inability to identify others' emotional states. Therefore further research on interpersonal difficulties is warranted.

Some limitations of the current study need to be acknowledged and should be addressed in future studies. The sample consisted of female adolescents admitted to an inpatient child and adolescent psychiatric unit and thus the results may not generalize to other samples. Therefore, male adolescents with NSSI should be included in further studies. In general, females perform better in recognition tasks than males (McClure, 2000). The presentation of pictures of facial expressions is of course not a real-life social interaction. The assessment of emotion recognition in daily social interactions would be of higher ecological validity and therefore would be an important next step for future studies. Furthermore, it will be important to describe the influence of comorbid disorders as the clinical control group was very heterogeneous. Finally, further research is needed to replicate these findings. Strengths of our study were the inclusion of a clinical control group, the use of several dynamic emotional facial expressions with color stimuli, the use of the morphing technique with 2% steps of intensity, and the use of *DSM-5* (American Psychiatric Association, 2013) research criteria for NSSI.

In summary, this is the first study on dynamic emotional facial recognition in adolescents with NSSI. The results of the present study demonstrate an accurate recognition ability of emotional facial expressions in female adolescents with NSSI and a lower valence rating of positive facial expressions.

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Contributors

TI made substantial contributions to the ideas of the paper and to the drafting and revision of the manuscript. CR contributed to the statistical analyses and the revision of the manuscript. MS contributed to the ideas of the paper, the recruitment, and the revision of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors declare that we have nonfinancial competing interests.

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Table 1

Demographic characteristics and clinical correlates of adolescents with NSSI (NSSI), clinical controls (CC), and nonclinical controls (NC), as well as analysis of variance results and group comparisons (C)

Characteristic	NSSI	CC	NC	<i>F</i>	<i>C</i>
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>		
Mean age (<i>SD</i>) in years	16.04 (1.29)	15.91 (1.38)	15.36 (1.59)	2.78	1, 2, 3
Questionnaire					
YSR total ^a	2.01 (0.09)**	1.89 (0.10)**	1.71 (0.15)**	60.42**	1 > 2 > 3
YSR ext ^a	1.17 (0.25) **	1.03 (0.18) *	.86 (0.33)**	13.91**	1 > 2 > 3
YSR int ^b	32.34 (9.18)**	23.71 (9.86)**	9.15 (6.89)**	80.96**	1 > 2 > 3
BDI-II	33.95 (12.20)**	21.16 (13.22)**	7.02 (7.72)**	75.93**	1 > 2 > 3
BSL-95	182.56 (68.71)**	116.27 (74.56)**	45.88 (28.32)**	60.91**	1 > 2 > 3

Note. YSR = Youth Self-Report, int = internalizing, ext = externalizing; BDI-II = Beck

Depression Inventory-II; * $p < 0.05$; ** $p < 0.01$; ^alog transformed; ^bsquare root transformed

Table 2

Mean percentage (standard deviation) of stages until the first correct recognition/response after sad and neutral mood induction for adolescents with NSSI (NSSI), clinical controls (CC), and nonclinical controls (NC), as well as post hoc comparisons for emotions.

Emotion	Neutral mood			Sad mood			Contrast: Goal vs. other emotions <i>F</i> (1, 118)
	NSSI	CC	NC	NSSI	CC	NC	
Anger	63.00 (16.71)	60.56 (12.19)	63.61 (13.31)	66.25 (12.82)	65.1 (15.9)	61.47 (11.9)	14.70**
Fear	65.06 (16.69)	65.33 (15.88)	62.17 (19.97)	67.07 (18.84)	67.47 (15.12)	62.85 (17.55)	19.47**
Disgust	64.90 (15.32)	60.15 (12.39)	60.26 (16.87)	59.92 (15.88)	62.98 (15.75)	59.24 (15.62)	0.42
Sadness	71.12 (12.3)	65.98 (13.52)	68.24 (13.31)	73.21 (12.48)	68.41 (16.9)	68.03 (11.90)	193.81**
Neutral	64.93 (25.63)	58.59 (19.64)	56.05 (24.00)	62.45 (25.28)	60.43 (20.21)	59.45 (22.85)	0.11
Happiness	47.57 (14.59)	42.10 (9.31)	46.81 (15.72)	47.33 (13.39)	46.10 (17.41)	45.00 (14.66)	486.41**

Note. There were no significant group differences. ** $p < 0.01$

Table 3

Mean percentage (standard deviation) of correctly recognized emotional facial expressions after sad and neutral mood induction for adolescents with NSSI (NSSI), clinical controls (CC), and nonclinical controls (NC)

Emotion	Neutral			Sad			Goal vs. target emotion
	NSSI	CC	NC	NSSI	CC	NC	<i>F</i> (1, 118)
Anger	89.01 (18.06)	84.69 (15.02)	88.92 (12.46)	88.63 (13.97)	89.28 (10.73)	89.21 (11.11)	136.95**
Fear	69.39 (20.96)	68.36 (22.11)	63.55 (27.20)	73.24 (22.75)	68.87 (19.84)	65.59 (23.13)	24.89**
Disgust	74.49 (22.87)	72.95 (25.29)	67.34 (25.42)	72.59 (24.38)	73.46 (22.57)	65.88 (22.74)	10.58**
Sadness	77.46 (22.27)	77.04 (19.57)	78.42 (20.43)	75.86 (20.65)	73.97 (20.59)	76.67 (19.05)	0.01
Neutral	53.65 (27.49)	60.20 (29.20)	55.97 (31.65)	56.09 (31.87)	57.14 (28.83)	55.39 (32.16)	74.24**
Happiness	98.05 (4.95)	96.42 (6.30)	97.08 (6.50)	98.70 (4.15)	98.97 (3.74)	99.70 (2.04)	743.93**

Note. There were no significant group differences. Multiple comparison procedures

(Bonferroni) were conducted at $p < 0.05$. ** $p < 0.01$

Table 4

Mean (standard deviation) of misinterpretations of neutral and fearful facial expressions as other emotions for adolescents with NSSI (NSSI), clinical controls (CC), and nonclinical controls (NC)

Emotion	Neutral facial expressions			Fearful facial expressions			Target vs. goal emotions <i>F</i> (1, 118)
	NSSI	CC	NC	NSSI	CC	NC	
Anger	0.11 (0.49)	0.04 (0.19)	0.18 (0.39)	0.14 (0.34)	0.14 (0.44)	0.29 (0.81)	136.95**
Fear	4.61 (3.38)	4.14 (2.94)	4.31 (3.50)				24.89**
Disgust	0.36 (0.61)	0.54 (1.37)	0.53 (1.00)	2.02 (2.05)	2.64 (1.98)	3.00 (2.71)	10.60**
Sadness	0.55 (0.76)	0.50 (0.69)	0.65 (0.97)	1.00 (0.94)	.96 (.99)	1.18 (1.20)	0.01
Neutral				0.48 (0.92)	0.61 (1.22)	0.33 (0.55)	74.24**
Happiness	0.09 (0.29)	0.29 (0.60)	0.24 (0.56)	0.11 (0.32)	0.04 (0.19)	0.16 (0.55)	743.93**

Note. ** $p < 0.01$

Table 5

Mean (standard deviation) valence and arousal ratings for adolescents with NSSI (NSSI), clinical controls (CC), and nonclinical controls (NC) and group comparisons (C)

Emotion	Arousal				Valence			
	NSSI (1)	CC (2)	NC (3)	C	NSSI (1)	CC (2)	NC (3)	C
Anger	5.95** (0.27)	6.13 (0.34)	7.14** (0.27)	1 < 3	5.64 (0.22)	5.70 (0.28)	5.03 (0.21)	
Fear	6.26 (0.28)	6.08 (0.35)	7.11 (0.27)		5.22 (0.23)	5.46 (0.29)	4.81 (0.22)	
Disgust	6.06 (0.28)	6.38 (0.36)	6.93 (0.27)		5.32 (0.23)	5.47 (0.29)	4.63 (0.22)	
Sadness	6.18** (0.25)	6.37 (0.32)	7.35** (0.24)	1 < 3	5.44 (0.23)	5.81 (0.29)	5.05 (0.22)	
Neutral	6.33 (0.31)	6.17 (0.40)	7.33 (0.30)		4.94* (0.23)	4.46 (0.29)	3.99* (0.22)	1 > 3
Happiness	6.52** (0.24)	7.12 (0.30)	7.83** (0.23)	1 < 3	4.66** (0.22)	3.97 (0.28)	3.00** (0.21)	1 > 3

Note. * $p < 0.05$, ** $p < 0.01$, indicating significant group differences. Multiple comparison procedure (Bonferroni) was conducted at $p < 0.05$. Valence: 1 = very pleasant, 9 = very unpleasant; Arousal: 1 = very excited, 9 = very calm