Quality and temporal properties of premonitory urges in patients with skin picking disorder

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Abstract

Skin picking is a newly recognized obsessive-compulsive spectrum disorder in DSM-5. Similar to some repetitive behaviors in Gilles de la Tourette syndrome (GTS) and obsessive-compulsive disorder (OCD), premonitory urges are assumed to play a critical role in maintaining skin picking behavior, by creating a vicious cycle. The present study is the first to investigate the quality of premonitory urges, as well as the temporal relationship between urges and skin picking behavior in individuals with skin picking disorder. Quality and intensity of premonitory urges was assessed in 15 individuals with skin picking. Urge quality was assessed with the translated University of São Paulo Sensory Phenomena Scale (USP-SPS). Urge intensity was assessed continuously over 20 min using a computer-based tool. Participants were instructed either a) to pick freely or b) to suppress their skin picking behavior. Skin picking events during the free and suppression condition were recorded on video and coded manually. Regarding the types of urges, individuals with skin picking reported mainly physical urge sensations (80%), visual ”just-right” feelings (80%), and urge-only sensations (80%) similar to urges reported by GTS and OCD patients. Moreover, the data showed a strong temporal relationship between the intensity of premonitory urges and the emergence of skin picking behavior (R^2 = .23) that was weakened when skin picking was suppressed (R^2 = .06). The results suggest that skin picking behavior is maintained by premonitory urges and that this vicious cycle of negative reinforcement can be, at least partially, broken by suppressing skin picking behavior.

Key words: Skin picking; excoriation disorder; premonitory urge; body focused repetitive behavior; Exposure with response prevention

1. Introduction

Skin picking (excoriation) disorder is defined as repetitive skin picking behavior accompanied by visible tissue damage resulting in significant distress and/or functional impairment (American Psychiatric Association, 2013). It includes behaviors such as squeezing, scratching, biting, or rubbing, the skin (Bohne, Wilhelm, Keuthen, Baer, & Jenike, 2002; Flessner & Woods, 2006; Keuthen et al., 2000; Tucker, Woods, Flessner, Franklin, & Franklin, 2011; Wilhelm et al., 1999). In contrast to Non-Suicidal Self Injurious behaviors, individuals with skin picking disorder are not preoccupied with harming or punishing themselves and injury is not the aim but an unwanted consequence of picking. Picking most commonly affects the face, arms, legs, hands, fingers, the back and chest as well as the stomach (Bohne et al., 2002; Calikusu, Yucel, Polat, & Baykal, 2003; Flessner & Woods, 2006; Grant, Odlaug, & Kim, 2007; Hayes, Storch, & Berlanga, 2009; Keuthen et al., 2000; Neziroglu, Rabinowitz, Breytman, & Jacofsky, 2008; Tucker et al., 2011). Epidemiological studies found lifetime prevalence rates of skin picking disorder of 1.2% - 1.4% (Keuthen, Koran, Aboujaoude, Large, & Serpe, 2010; Monzani et al., 2012). Patients with skin picking disorder experience lower quality of life (Odlaug, Kim, & Grant, 2010) and significantly higher lifetime rates of affective disorders, anxiety and eating disorders, substance use and impulse control disorders (Odlaug et al., 2013).

Based on shared characteristics (e.g. repetitive, habit-like symptoms), it has recently been proposed that a number of diagnoses may fall on the same spectrum, including skin picking disorder, trichotillomania (hair pulling), Gilles de la Tourette's syndrome (GTS) and obsessive-compulsive disorders (OCD) (Ferrao, Miguel, & Stein, 2009; Grant, Stein, Woods, & Keuthen, 2012; Leckman et al., 1994; Lochner & Stein, 2010; Stein et al., 2010). One of these shared characteristics are premonitory sensory phenomena. Similar to repetitive behaviors in patients with OCD (Ferrao et al., 2012), trichotillomania (Flessner et al., 2008;

Snorrason, Belleau, & Woods, 2012) and GTS (Brandt, Beck, Sajin, Baaske, et al., 2016; Capriotti, Brandt, Turkel, Lee, & Woods, 2014; Himle, Woods, Conelea, Bauer, & Rice, 2007; McGuire et al., 2015), many skin picking behaviors are not executed suddenly and "without warning" but appear to be accompanied by anticipatory sensory phenomena or "urges" (Twohig, Hayes, & Masuda, 2006). Urges (also "sensory phenomena", "premonitory sensations", "not just-right feelings") are uncomfortable bodily sensations that typically occur at the site where a repetitive behavior (i.e., skin picking, tic, compulsion, hair pulling) is about to occur but have also been described as a general inner tension (Cavanna & Nani, 2013). Studies have shown that the majority of individuals with skin picking (92.5%) experience recurrent urges to pick their skin (Lochner, Grant, Odlaug, & Stein, 2012) and that 76% - 78% (Flessner & Woods, 2006; Tucker et al., 2011) experience urges almost always prior to picking episodes. However, very little is known about premonitory sensations in skin picking, whereas the phenomenon is receiving increasing attention in GTS and OCD research (Brandt, Beck, Sajin, Baaske, et al., 2016; Brandt et al., 2018; Capriotti et al., 2014; Ferrao et al., 2012; Himle et al., 2007; McGuire et al., 2015).

While descriptions of sensory phenomena vary (Cavanna & Nani, 2013), they are generally assumed to drive repetitive behaviors by increasing until a behavior is executed and decreasing as a consequence of the behavior (Brandt, Beck, Sajin, Baaske, et al., 2016; Capriotti et al., 2014; Himle et al., 2007; McGuire et al., 2015). This pattern has been hypothesized to constitute a vicious cycle perpetuating repetitive behaviors by negative reinforcement (Taylor, Abramowitz, & McKay, 2007). The temporal relationship between urges and repetitive behaviors has been experimentally studied in GTS (Brandt, Beck, Sajin, Baaske, et al., 2016) and OCD patients (Brandt et al., 2018) but not in skin picking. Although this temporal pattern has not been systematically investigated in skin picking, behavioral interventions crucially rely on its existence.

Established cognitive-behavioral therapeutic (CBT) interventions (Keuthen et al., 2015; Lochner, Roos, & Stein, 2017) typically target urges. The habit reversal training (HRT), which is part of CBT, uses urges to predict skin picking behavior and introduces a competing response rendering the skin picking behavior impossible (Teng, Woods, & Twohig, 2006). Acceptance and commitment therapy (ACT) aims to help patients accept urges as events in their mind, which don't need to be attended, monitored or dealt with in any specific way (Twohig et al., 2006). In contrast to pharmacological interventions, behavioral treatments have demonstrated significant efficacy (Lochner et al., 2017; Schumer, Bartley, & Bloch, 2016). CBT interventions encourage patients to prevent or postpone behavioral responses to internal or external triggers, thus challenging experiences and beliefs regarding uncontrollability of repetitive behaviors despite increasing urge intensity. While it has been experimentally shown that tics (Brabson et al., 2016; Brandt, Herrmann, Kerner Auch Koerner, & Munchau, 2017; Capriotti, Turkel, Johnson, Espil, & Woods, 2017) and compulsions (Abramowitz, 1996) can be successfully suppressed or postponed for some time, the same has not been investigated in skin picking disorder.

The current study was conducted to experimentally address several open questions regarding the urge to pick one's skin. We hypothesized that there is a significant relationship between the urge to pick and actual skin picking behavior. With regard to the temporal relationship between urges and skin picking, we hypothesized that the urge to pick increases before a picking event starts and decreases during the course of a skin picking event. Moreover, we predict that participants with skin picking disorder are able to postpone skin picking behavior and that urge intensity increases overall when skin picking behavior is postponed or suppressed.

2. Material and methods

2.1 Participants

Participants were recruited from the general population in Luebeck, Germany. The study was advertised in the city center, on a Website "in my skin / in meiner Haut", at the University campus and the music university campus Luebeck, using posters. Participants received 10 EUR per hour and a clinical assessment in return for their participation. The final sample consisted of fifteen participants. Inclusion criteria comprised the confirmed diagnosis of the skin picking disorder according to DSM5 (American Psychiatric Association, 2013), experiencing premonitory urges and an age of > 18 years. All participants received a clinical interview and diagnosis confirmation by an expert in the area of OC spectrum disorders (B.Z.). Exclusion criteria were: self-harming behavior associated with Borderline Personality Disorder or Non-Suicidal Self Injury (as indicated by the use of instruments for harming oneself), substance use or psychosis according to the SCID (DSM-IV), current psychotherapeutic or pharmacological treatment, and presenting clinically relevant dermatological conditions other than those, following skin picking. Three out of eighteen initially screened participants fulfilled exclusion criteria (Non-Suicidal Self Injury, substance use, neurodermatitis) and were excluded from analysis. Fifteen participants diagnosed with skin picking disorder aged 25.8 years (± 3.4 SD; 4 male) were thus included in this study. All had A-levels, 10 were university students or in vocational training, 2 were employed, 1 self-employed. Three participants fulfilled criteria for another diagnosis according to DSMIV/5 (trichotillomania, adjustment disorder and panic disorder).

2.2 Clinical assessment

In order to assess comorbidities and to validate the exclusion criteria, all participants had to undergo the German version of Structured Clinical Interview for DSM-IV (SCID; (Wittchen, Zaudig, & Fydrich, 1997), an economic and reliable diagnostic instrument (Lobbestael, Leurgans, & Arntz, 2011). The overall severity of the skin picking disorder was

assessed using the Skin Picking Scale – Revised (SPS-R), a self-report scale with high internal consistency and good construct validity as well as good convergent and discriminant validity (Gallinat, Keuthen, & Backenstrass, 2016). For the exploratory examination of premonitory urges, we used an in-house German translation (see supplementary materials) of the University of São Paulo Sensory Phenomena Scale (USP-SPS; (Rosario et al., 2009; Sampaio, McCarthy, Mancuso, Stewart, & Geller, 2014). For the English version of the USP-SPS, good reliability and validity has been reported (Sampaio et al., 2014). Intensity of premonitory urges to engage in skin picking was assessed using the Real-time Urge Monitor (RUM), a computer based tool to continuously assess the intensity of premonitory urges, an instrument with high convergent validity and face validity (Brandt, Beck, Sajin, Anders, & Munchau, 2016; Brandt, Beck, Sajin, Baaske, et al., 2016). The RUM was adapted for this study: urge intensity was reported through a foot pedal instead of a mouse pad to allow participants to use their hands to pick their skin (see experimental design).

The study was reviewed and approved by the local ethics committee and conformed to the Declaration of Helsinki. All participants gave their written informed consent.

2.3 Experimental design

First, participants completed the USP-SPS in order to increase their awareness of sensory phenomena for the subsequent measurement. Thereafter, the subjective intensity of premonitory urges over time was assessed using the RUM (Brandt, Beck, Sajin, Baaske, et al., 2016), displayed on a laptop. The laptop screen showed a coordinate system with an intensity scale on the vertical axis ranging from 0-100. On this scale, 0 corresponded to no urge and 100 represented the strongest urge participants typically experience. Time was represented on the horizontal axis. After pressing the start button, a countdown (3s-2s-1s-0) informed participants about the time to start. The urge rating was continuously shown and

updated as a sliding window covering the last 10s of the recording. Participants were asked to continuously and immediately adjust the level of a blue line to their current urge intensity level using a foot pedal (Figure 1). All participants practiced the task for 3 minutes. Urge intensity was measured during a free picking condition (instruction: "Please report the urge to pick your skin immediately and continuously") and during a suppression condition (instruction: "Please suppress the execution of skin picking in the next 10 mins for as long as you can"). Each condition was assessed in two 10-minute blocks, separated by short breaks between the blocks. The order of conditions (free – free – suppression – suppression) was kept constant across participants to avoid after-effects of the suppression condition on picking frequency or urge intensity in the free condition. Skin picking was captured by video using a Panasonic HDC-TM700, with a frame rate of 25 frames per second. Skin picking or picking events were defined and rated as the time between the start of scratching, ripping, squeezing, rubbing or biting skin and the time the behavior stopped. Subsequently, the participants filled out the SPS-R. The task was programmed in Matlab. The task, study data and syntax are available at https://osf.io/b9un3/files/. No part of the study procedures was pre-registered prior to the research being conducted

2.4 Statistical Analysis

2.4.1 Data preparation

No part of the study analyses was pre-registered prior to the research being conducted. Urge intensity ratings were sampled at 10 Hz, resulting in an urge intensity time series of 6000 data points for each block (10 min) and 12000 per condition. The first 10s of each block were discarded to allow for time until participants had adapted their urge rating on the RUM to the correct intensity level. The remaining data points were down-sampled to 1180 data points overall per condition (i.e., one data point per second). Occurrence of skin picking

behavior was rated by two independent raters from the video recordings as absent (0) or present (1) for each second of the recording (Intraclass correlation coefficient free condition = .94; suppression condition = .92). A skin picking variable was calculated from both raters, representing picking (1) whenever one of the raters rated skin picking as present.

2.4.2 Average occurrence and duration of skin picking and urge intensity across conditions

For the group level analysis, average urge intensities, picking frequencies and the duration of skin picking events in the free picking condition and the suppression condition were compared using paired samples *t*-tests.

2.4.3 Temporal relationship between urge intensity and single skin picking events

To assess the temporal relationship between urge intensity and picking behavior we used three different approaches. First, we estimated the amount of variance in the occurrence of picking behavior that could be explained by self-reported urge intensity in each condition. For this purpose, we z-standardized the urge intensity time series for each participant (separately for the free and the suppression condition) and concatenated the z-standardized urge intensity ratings and skin picking episodes across participants. We then computed binary logistic regressions with urge intensity as the independent variable and occurrence of picking behavior as the dependent variable.

Second, to investigate whether urge intensity increased prior to a skin picking event and decreased following a skin picking event on average, Bonferroni-Holm corrected t-tests were conducted to compare urge intensity at the start and the end of a picking episode to the

urge intensity in no-picking intervals. Furthermore, the likelihood to pick according to urge intensity was determined for each individual (supplementary table 1).

Third, to examine the properties of the temporal distribution of the urge trajectory around single picking events in detail, we evaluated four parameters characterizing the picking-related tracks of each participant. These parameters included: a) *peak latency*, defined as the time of maximum urge intensity relative to the end of the picking event (if there was more than one maximum within the time window, the one closer to the middle of the picking event was defined as the peak); b) *width*, defined as the interval between the last local minimum before the peak to the first local minimum after peak; c) *skewness* of the urge distribution (positive skewness indicates that the right tail is longer than the left tail and vice versa); and d) *excess kurtosis* of the urge trajectory (positive excess kurtosis indicates a peaked peak as compared to normal distribution, negative excess kurtosis indicates a flatter peak). All parameters were tested against the null-hypothesis using one-sample t-tests. Differences between the conditions were analyzed using paired samples t-tests. Bonferroni-correction was applied regarding these three t-tests per parameter, i.e. results were considered significant if $p \leq .016$. Effect sizes were calculated using *Cohens'd*.

3. Results

3.1 Clinical Assessment

Participants reported a mean duration of the skin picking disorder of 12.4 (± 7.49) years. The average age at onset was 13.4 (± 6.43) years. On average, participants reported a daily picking time of 1-3 hours in the past week. Participants had an average SPS-R score of (M ± SD) 12.5 ± 2.80, with an average impairment of 4.00 ± 2.14.

3.2 Quality of Premonitory Sensations

An exploratory examination regarding quality of premonitory sensations, based on the USP-SPS, revealed that physical sensations, visually triggered "just-right" feelings, and urge-only phenomena were the most common types of premonitory sensations (see Table 1). The mean severity score of the USP-SPS was 6.27 ± 2.96. However, 13 out of 15 participants preferred the free response options over the structured descriptions in the USP-SPS, indicating that the questionnaire is not particularly suited to assess urges in individuals with skin picking disorder. Participants described the urge phenomena most commonly as "uncomfortable sensations in the skin, or body sensations that come before or along with the repetitive behaviors" (12 out of 15; see also Rosario et al., 2009), as "a need for the skin to look in a certain way or just-right" (12 out of 15) or as "an urge to do the repetitive behavior without any sensations or feelings" (12 out of 15).

3.3 Average Occurrence and Duration of Skin Picking Behavior and Urge Intensity across Conditions

The number of skin picking events was significantly lower in the suppression condition (5.87 ± 7.57) than in the free picking condition (21.20 ± 8.06; $t(14) = 8.37$, $p < .001$, $CI_{lower} = 11.40$, $CI_{upper} = 19.26$, $d = 1.37$), indicating that participants successfully suppressed skin picking when asked to do so. Moreover, the average skin picking event was significantly shorter in the suppression condition (6.59s ± 7.11s) than in the free condition (16.07s ± 6.87s; $t(9) = 3.32$, $p = .009$, $CI_{lower} = 3.02$, $CI_{upper} = 15.94$, $d = 1.62$), indicating participants' ability to end skin picking prematurely. The average urge intensity was higher in the suppression condition (25.91 ± 23.38) than in the free picking condition (17.20 ± 16.79; $t(14) = -2.76$, $p = .015$, $CI_{lower} = -15.48$, $CI_{upper} = -1.94$, $d = .32$).

3.4 Temporal Relationship between Urge Intensity and Single Skin Picking Events

A binary logistic regression showed that approximately 23% of the variance in the occurrence of skin picking could be explained by variance in urge intensity (Nagelkerke $R^2 = .23$, $\chi^2(1) = 2940.54$, $p < .001$; Odds Ratio = 2.74, Wald(1) = 2198.58, $p < .001$) in the free condition, suggesting that skin picking became more likely in connection with higher urge intensity. In the suppression condition, only approximately 6% of the variance in the occurrence of skin picking behavior could be explained by the variance in urge intensity (Nagelkerke$R^2 = .06$, $\chi^2(1) = 271.33$, $p < .001$; Odds Ratio = 1.74, Wald(1) = 311.25, $p < .001$), indicating that urge intensity varied more independently of skin picking during suppression. Data for the pick-urge relationship in each individual participant also showed that the likelihood of a picking event was consistently higher across participants when the urge to pick was high than when it was low (supplementary table 1).

A curvilinear regression showed a quadratic relationship (increase then decrease) of the urge to pick over time [$F(2,32) = 40.16$, $p < .001$, $R^2 = .72$, b1 = .006, b2 = -.002] in the free condition and a cubic (increase, no significant decrease) relationship [$F(3,37) = 82.19$, $p < .001$, $R^2 = .87$, b1 = .024, b2 < .001, b2 < .001] in the suppression condition.

In the free condition, paired samples *t*-tests showed that the average urge intensity was higher when participants started and ended a picking event than when they did not pick, i.e. the urge intensity increased significantly prior to the start of a picking event ($t(14) = 3.99$, $p = .001$, $CI_{lower} = .27$, $CI_{upper} = .91$, $d = 1.09$) and decreased significantly after the end of a picking event ($t(14) = 7.84$, $p < .001$, $CI_{lower} = .63$, $CI_{upper} = 1.11$, $d = 2.19$). These differences were not significant in the suppression (all $t < 1.3$), suggesting that urge intensity did not decrease significantly after a picking event ended in the suppression condition (Figure 3; see supplementary materials for individual urge-trajectories around skin picking events).

3.5 Parameters of the Urge Trajectory

The average width of the picking-related urge trajectory was 33.33s ± 13.63 (average urge minimum before picking event = -16s ± 5; average urge minimum after picking event = +18s ± 11) in the free condition and 41s ± 12 (-18s ± 10 to +22s ± 12) in the suppression condition (Figure 3). Although the average width, or duration of picking-related urges did not differ significantly between the free picking condition and the suppression condition ($t(9) = -0.75$, $CI_{lower} = -15.71$, $CI_{upper} = 7.91$, $p = .47$), the width of the picking-related urge trajectory relative to the length of the picking event was significantly wider in the suppression condition than the free condition ($t(9) = -4.69$, $p = .001$, $CI_{lower} = -11.72$, $CI_{upper} = -4.09$, $d = 2.16$).

T-tests revealed that urge intensity peaked on average, significantly before a skin picking event ended in the free condition ($t(14) = 12.36$, $CI_{lower} = 12.84$, $CI_{upper} = 18.23$, $p < .001$, $d = 1.28$) and the suppression condition ($t(9) = 6.26$, $CI_{lower} = 10.16$, $CI_{upper} = 21.64$, $p = .21$).

The urge trajectory was not significantly skewed in the free (-0.13 ± 0.85; $t(14) = -0.60$, $CI_{lower} = -.60$, $CI_{upper} = .34$, $p = .56$) or the suppression condition (-0.29 ± 1.46; $t(9) = -0.64$, $CI_{lower} = -1.34$, $CI_{upper} = 0.75$ $p = .54$). The excess kurtosis of the urge trajectory did not differ from a normal distribution in the free (-0.28 ± 2.39; $t(14) = -0.45$, $CI_{lower} = -1.60$, $CI_{upper} = 1.05$, $p = .66$) or the suppression condition (1.86 ± 5.49; $t(9) = 1.07$, $CI_{lower} = -2.07$, $CI_{upper} = 5.78$ $p = .31$).

4. Discussion

4.1 Quality of Premonitory Sensations

This study is the first to examine quality and temporal properties of premonitory sensory phenomena in skin picking disorder. The USP-SPS and free response options indicate that the majority of participants investigated in this sample experienced physical

sensations preceding or accompanying skin picking events, externally triggered visual "just-right" feelings and urge-only sensations. The results show parallels to premonitory sensations described by both GTS and OCD patients (Ferrao et al., 2012; Reese et al., 2014). Externally triggered "just-right" feelings are very common among patients with GTS and OCD (Ferrao et al., 2012; Reese et al., 2014). However, while the most common premonitory sensations in OCD patients are "just-right" feelings (Ferrao et al., 2012), GTS patients most often describe urge-only phenomena preceding tics (Kwak, Dat Vuong, & Jankovic, 2003).

Similar to the "uncomfortable sensation in the skin" that participants with skin picking disorder described in this study, 57% of OCD patients with urges experience musculoskeletal feelings (Ferrao et al., 2012). GTS patients commonly report feeling premonitory urges at the site where a tic will occur (Leckman, Walker, & Cohen, 1993) and have characterized them as "warm", "cold", "pressure-like", or "tickling" sensations (Banaschewski, Woerner, & Rothenberger, 2003). The exact sensory quality of premonitory sensations in skin picking patients will need to be further investigated. Also striking is the parallel between "a need for the skin to look in a certain way or just-right" and just-right feelings described by OCD patients with symmetry obsessions and ordering compulsions.

Overall, subjective descriptions of premonitory urges associated with repetitive behaviors are similar across these three neuropsychiatric disorders. Although diagnostic categories are becoming increasingly refined, there has been a debate about whether mental disorders would be more appropriately viewed as dimensional constructs (Kraemer, Noda, & O'Hara, 2004). Skin picking disorder and chronic tic disorders can be considered "body-focused repetitive behaviors" (Grant et al., 2012) and are also often considered to be part of the OCD spectrum (Leckman et al., 1994; Lochner & Stein, 2010). Our findings regarding

the qualitative description of urges related to skin picking support the idea that these disorders belong to the same spectrum.

4.2 Temporal Relationship between Urge Intensity and Skin Picking Events

When participants were not asked to suppress skin picking, urge intensity started increasing prior to a skin picking event, continued to increase during the skin picking event but started to decrease even before the skin picking event ended. This temporal association suggests that picking behavior may arise due to an increasing urge to pick and that the urge intensity has to return to a low level before individuals will stop picking. Data from individual participants confirmed that this pattern was consistent across the majority of participants. Hence, reporting the average urge-skin picking relationship is unlikely to obscure a variety of individual patterns in urge-picking relationship in individual patients (Brabson et al., 2016). The findings are in line with a model that proposes that the relationship between premonitory urges and repetitive behaviors, such as skin picking, may constitute a vicious cycle, whereby the execution of the behavior leads to a relief in urge intensity, thereby negatively reinforcing the behavior to occur (Taylor et al., 2007). Evidence for this mechanism has already been found with regard to the urge to tic (Himle et al., 2007; Houghton, Capriotti, Conelea, & Woods, 2014; McGuire et al., 2015) and the urge to neutralize intrusive thoughts (Rachman, Shafran, Mitchell, Trant, & Teachman, 1996; Salkovskis, Westbrook, Davis, Jeavons, & Gledhill, 1997).

Given the similarities between different repetitive behaviors (tics, compulsions, skin picking) regarding the urge-behavior relationship (Brandt, Beck, Sajin, Baaske, et al., 2016; Brandt et al., 2018), it would be interesting to investigate whether the urge experience has overlapping neural mechanisms among these disorders and whether it can all be successfully treated with analogous behavioral interventions. Generally, it has been suggested that there is

"psychobiological overlap" between tics, OCD and "body focused repetitive behaviors", such as skin picking disorder and trichotillomania (Phillips et al., 2010). Comorbidity rates between skin picking disorder, trichotillomania (Snorrason et al., 2012) OCD (Torres et al., 2016) and tics / GTS (Mathews et al., 2004) are high and an association with fronto-striatal alterations is established in all four disorders, albeit more robustly in tics (Ganos, Roessner, & Munchau, 2013) and OCD (Menzies et al., 2008) than in skin picking (Grant, Odlaug, Hampshire, Schreiber, & Chamberlain, 2013) and trichotillomania (Roos, Grant, Fouche, Stein, & Lochner, 2015). More specifically, there is evidence that the presence/awareness of urges in both patients with OCD (Subirà et al., 2015) and GTS (Draper, Jackson, Morgan, & Jackson, 2016) is associated with structural alterations in the sensorimotor cortex but it is at present unclear whether, ontogenetically, these alterations precede or follow the occurrence of urges. No studies have investigated the neural correlated of urges in skin picking disorder. The parallels in subjective quality as well as temporal trajectory of urges in individuals with skin picking disorder, GTS and OCD further support the assumption of a common mechanism underlying the maintenance of these distinct repetitive behaviors.

4.3 Suppression of Skin Picking

This study also provides first insight into the ability to control skin picking behavior. On average, participants achieved over 50% reduction in the duration of skin picking events and 75% reduction in occurrence of skin picking events. One third of the participants were able to suppress skin picking behaviors completely. Suppression of skin picking behavior led to an increase in urge intensity, underlining the close relationship between urges and skin picking, as the increase in urge was probably due to delaying and shortening skin picking events. In contrast to the free condition, the urge to pick increased over a longer time period, peaking even after participants stopped themselves from picking and did not return to the

baseline level. These results might indicate that participants were putting off picking, despite increasing urge levels and refrained from picking, even though the urge to pick had not been satisfied. Skin picking events were also less well predicted by urge intensity in the suppression condition than in the free condition. This is in line with previous findings in GTS and OCD patients (Brandt, Beck, Sajin, Baaske, et al., 2016; Brandt et al., 2018) and suggests that the relationship between urges and skin picking statistically weakens during suppression. This might be due to participants delaying picking despite high urge intensities and stopping themselves from picking, although urge intensity has not decreased. While this may alter the immediate gratification of the removal of an uncomfortable stimulus (urge) by a behavior (picking), it is unclear what the consequences are in terms of operant conditioning. Furthermore, urges started to increase and decrease without picking events always providing relief when skin picking was suppressed. This observation is in line with the assumption underlying the use of therapies involving exposure with response prevention elements (Keuthen et al., 2015; Lochner et al., 2017). ERP assumes that avoidance behavior (skin picking) can be extinguished by exposing the individual to the stimulus (urge) that would normally trigger the behavior. Similarly, habit reversal training also successfully uses de-coupling of premonitory urges and skin picking behavior to treat skin picking (Moritz, Fricke, Treszl, & Wittekind, 2012; Teng et al., 2006; Twohig et al., 2006). However, these principles are largely derived from research into and treatment of fear and it is unclear how they apply to skin picking disorder.

4.4 Limitations

Several limitations should be considered. First, due to the paucity of prior research, the questionnaires used to examine the quality of premonitory urges were not specific to skin picking disorder. The findings of this study might be useful for designing such a

questionnaire. Judging urge intensity over time depends on interoceptive awareness. The RUM is therefore subject to some error variance, both at the inter- and the intra-individual level. On the one hand, the second-by-second timing of urge intensity should be interpreted with care bearing variable individual response delays in mind. On the other hand, results regarding the comparison between the free and the suppression condition should be robust because this limitation affects both. The everyday validity of the results is limited due to the setting of the experiment in a laboratory and the complexity of the task. Moreover, the current study investigated premonitory urges associated with skin picking behavior in general, without dissociating different qualities of sensory phenomena. Notably, the current study is the first one examining different qualities of sensory phenomena in skin picking disorder, thus, generation of hypotheses was one aim of the project. Consequently, we should ask whether different qualities of premonitory urges are associated with a different time-course of urge intensity as a next step. Furthermore, the reported results are averages across all skin picking events and may therefore include skin picking events without premonitory urges, as we did not differentiate these two phenomena. In order to do so, individual thresholds would need to be installed, determining how much increase in urge intensity in relation to a skin picking event constitutes a relevant increase.

Several studies reported a notable amount of co-morbid conditions in individuals with SPD. In contrast, our purely non-clinical sample in the present study was mostly monosymptomatic and consisted only of highly educated participants. On the one hand, this makes our sample very homogeneous and allows to attribute our findings to skin picking, on the other hand generalizability of the results to samples seeking help for severe skin picking (with more frequent comorbidity) is limited.

We conclude that a significant temporal relationship between the intensity of premonitory urges and the execution of skin picking behavior can be found, which is

transiently attenuated when skin picking behavior is suppressed. The results support the hypothesis of an underlying circle of negative reinforcement maintaining skin picking, similar to mechanisms assumed to underlie other disorders of the (broader) OC spectrum such as trichotillomania or tics.

Table 1

Quality of premonitory urges

Premonitory Urges	%	n
Physical Sensation	80.0	12
"Just-Right" feelings triggered by external	93.3	14
Sensations		
tactile	73.3	11
visual	80.0	12
auditory	13.3	2
Feeling of incompleteness/need to feel "just right"	60.0	9
Urge-only	80.0	12
Energy that builds up and needs to be released	66.7	10

Distribution of the quality of reported skin picking experiences in the current sample according to the University of Sao Paulo Sensory Phenomena Scale (UPS-SPS).

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Figure legends

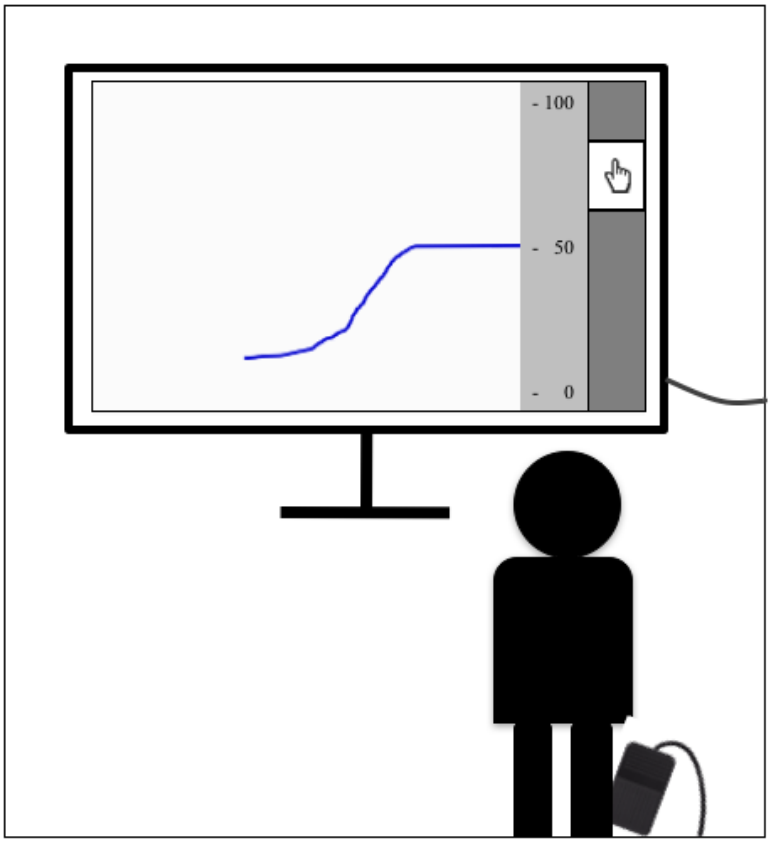

Figure 1. Real-time urge monitor. The real-time urge monitor displayed a blue line moving across the screen continuously from right to left. Participants were asked to continuously indicate the intensity of their current urge to pick their skin on a scale from 0 to 100, using a foot pedal. The screen always displayed the last 10s of urge ratings.

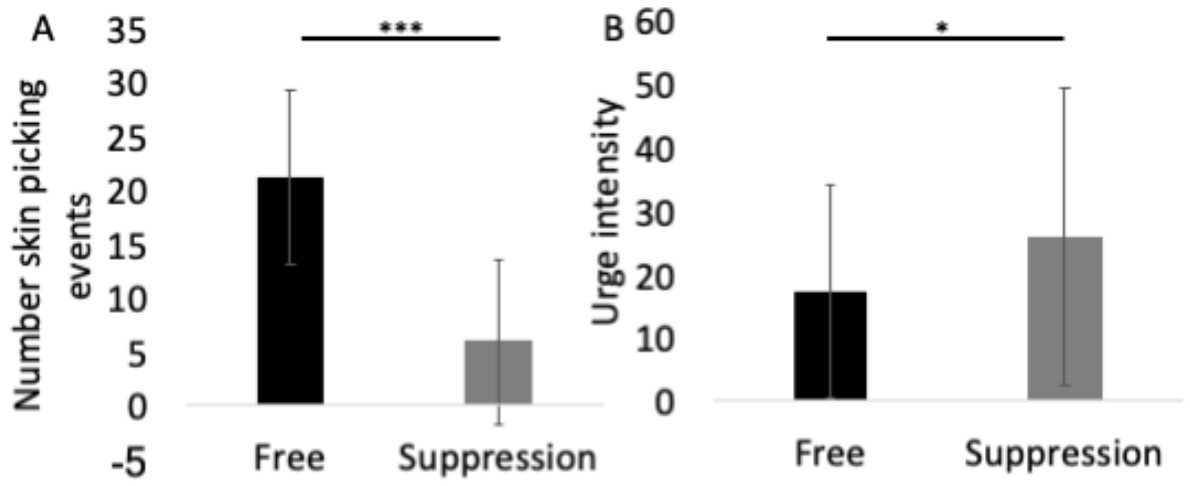

Figure 2. Skin picking events and urge intensity. Average number (± 1SD) of skin picking events (A) and average urge intensity (range: 0-100) (B) across participants in the free picking and the suppression condition.

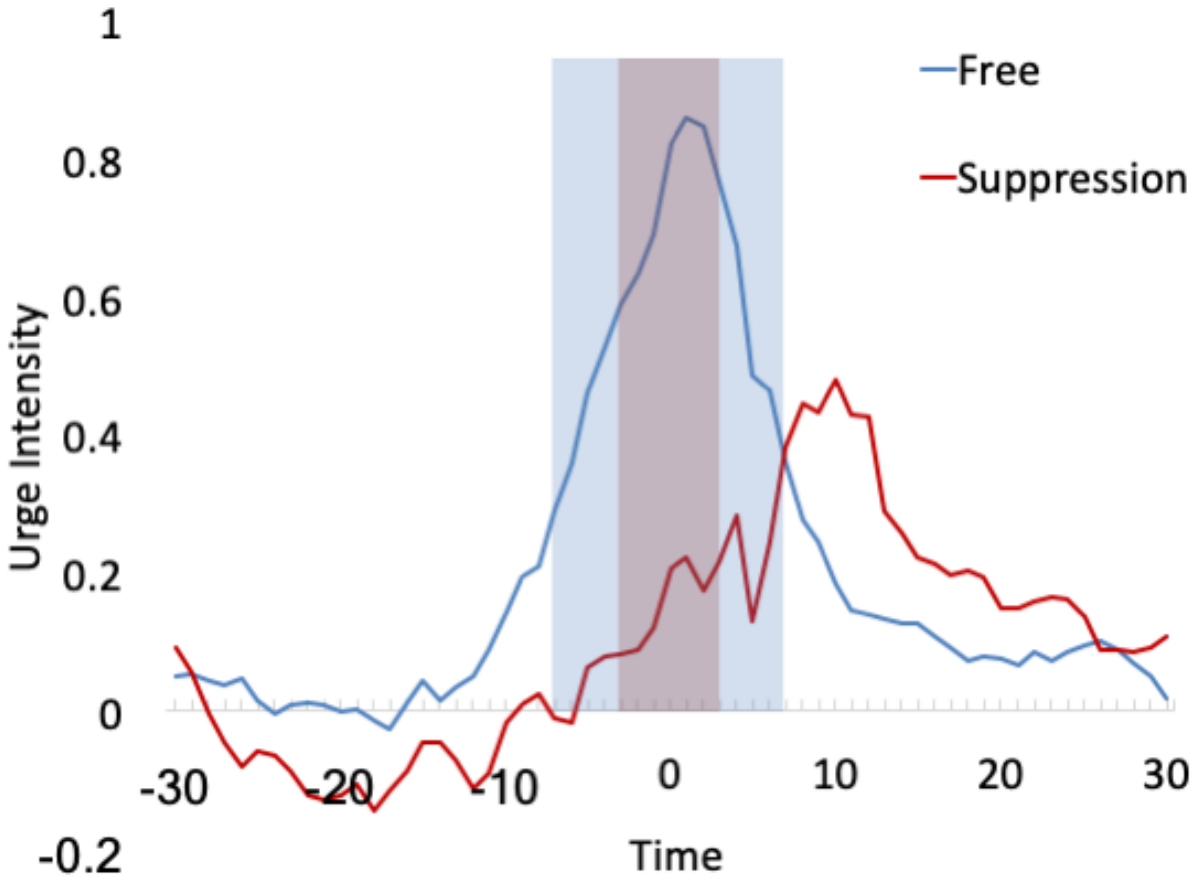

Figure 3. Urge trajectory. Temporal trajectory of the average z-standardized urge intensity around the average skin picking event during free picking (blue) and suppression (red). Time zero represents the middle of the average skin picking events; their duration is represented by the blue and red colored frames.

Supplementary materials