

**Can a Variant of the Implicit Association Test Detect Nonsuicidal Self-Injury in a
Clinical Population? A Registered Report**

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Abstract

Background. Nonsuicidal self-injury (NSSI) is a severe and prevalent mental health problem. Measures to detect which individuals are at risk for NSSI would be valuable for clinical practice. However, we still lack strong predictors of future NSSI behaviour, with the most notable exception being prior NSSI behaviour. Yet, the measurement of prior NSSI behaviour with self-report measures can be difficult because individuals may be motivated to conceal this harmful behaviour. To overcome this problem, an implicit measure has been developed that assesses automatic responding to statements about prior NSSI behaviour (i.e., the past nonsuicidal self-injury Implicit Association Test: P-NSSI-IAT). Previous studies tested the predictive utility of this measure in online studies with samples of at risk participants and produced promising results. The current study aims to test the predictive utility of the P-NSSI-IAT for NSSI in clinical samples. **Method.** We will target outpatients ($N = \text{xxx}$) and examine whether the P-NSSI-IAT detects self-rated prior NSSI and future likelihood of NSSI. **Results.** **xxx. Conclusion.** **xxx**

Keywords: nonsuicidal self-injury, implicit measures, past behaviour, prediction, clinical population, outpatients

Key messages:

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Can a Variant of the Implicit Association Test Detect Nonsuicidal Self-Injury in a Clinical Population? A Registered Report

Nonsuicidal self-injury (NSSI), which is defined as the direct and deliberate destruction of one's own body tissue in the absence of lethal intent (Nock, 2010, p. 340), is a severe problem. Besides physical scars and infections, NSSI can result in feelings of guilt and shame towards the self (Long, 2018; Rosenrot & Lewis, 2020) and evoke stigmatizing behaviour from family, peers (Doyle, 2017; Oldershaw et al., 2008), and even health care professionals (Saunders et al., 2012). While NSSI is typically conceptualized as non-suicidal, prior NSSI behaviour has been shown to be a robust risk factor and predictor of suicidal thoughts and behaviours (Franklin et al., 2017; Griep & MacKinnon, 2020; Kiekens et al., 2018; Turner et al., 2013; Whitlock et al., 2013). NSSI is a highly prevalent problem. Lifetime prevalence rates have been estimated at 4-6% in general adult populations (Klonsky, 2011; Liu, 2021) and at 45% in adult clinical populations (Andover & Gibb, 2010), with even higher prevalence rates in younger age groups (e.g., Swannell et al., 2014). Given the severity and prevalence of NSSI, it is important for practitioners to assess which patients are at risk of NSSI behaviour. Assessment methods to detect and predict NSSI, could provide a valuable opportunity to prevent NSSI and suicidal behaviour.

Potential predictors and risk factors for NSSI have been investigated for over a decade. Nevertheless, results from a recent meta-analysis on studies longitudinally predicting NSSI, revealed that most factors show weak predictive utility, suggesting limited clinical value (Fox et al., 2015). One notable exception was prior NSSI behaviour, which showed to be the strongest risk factor for future NSSI. Results from individual studies have shown that prior self-harm behaviour outperforms other predictors when longitudinally forecasting self-harm (Janis & Nock, 2008), and have revealed that prior NSSI behaviour was the only significant predictor for NSSI between several follow-ups (Tuisku et al., 2014). Moreover, results from a

recent study using machine learning techniques showed that prior NSSI behaviour was the most important predictor across several time points (Fox et al., 2019). As such, assessing prior NSSI behaviour could be a valuable strategy for predicting future NSSI and related behaviours in clinical contexts.

Importantly, however, merely asking individuals about prior NSSI behaviour in clinical settings could be problematic. Patients might be reluctant to disclose NSSI behaviour in light of potential negative consequences, such as feelings of shame, fear of stigmatization, and fear of hospitalization (Long, 2018; MacDonald et al., 2020; Simone & Hamza, 2020). The addition of implicit measures to screening procedures for NSSI risk detection could provide a solution to this problem. Implicit measures are measurement outcomes that reflect responding under automaticity conditions (De Houwer et al., 2009; De Houwer & Moors, 2012). For instance, studies have shown that responding on certain implicit measures, such as the implicit association test (IAT; Greenwald et al., 1998) and some of its variants, is far less controllable than responding on self-report measures (e.g., Agosta et al., 2011; Egloff & Schmukle, 2002; Kim, 2003; Stieger et al., 2011). As such, these measures could be less susceptible to deception.

Because of their potential benefits over self-report measures, scholars have developed implicit measures for predicting NSSI and other self-harm behaviours (e.g., Nock et al., 2010; Nock & Banaji, 2007). Notably, most of these measures do not target predictors that have previously shown to be strong forecasters of NSSI (for an exception see Gray et al., 2021). For instance, one of the most frequently used implicit measures in this domain, referred to as the self-injury implicit association test (SI-IAT; Nock & Banaji, 2007), targets self-identification with NSSI behaviour. In the SI-IAT, participants categorize stimuli regarding the self (e.g., the word “me”) and others (e.g., the word “them”) together with self-harm stimuli and non-self-harm stimuli (e.g., pictures of skin that has (not) been cut) as fast as

possible using two keys on the keyboard. When participants show better performance on trials in which stimuli regarding the self and self-harm stimuli share the same response key than on trials in which stimuli regarding the self and non-self-harm stimuli share the same response key, it is inferred that these individuals automatically identify themselves with self-injurious behaviour. While several studies have shown that the SI-IAT can discriminate between injury groups and non-injury groups (Glenn et al., 2017; Nock & Banaji, 2007; Powers et al., 2021), evidence regarding its utility to prospectively predict NSSI behaviour has been mixed. Two studies demonstrated that the SI-IAT predicts NSSI over time (Cha et al., 2016; Glenn et al., 2016), while other studies failed to find such effects (Cha et al., 2016; Franklin et al., 2014; Glenn & Klonsky, 2011; Powers et al., 2021).

A promising new avenue for NSSI risk detection in clinical practice may involve the development of measures that (a) target predictors shown to be strong forecasters of NSSI and (b) are less susceptible to deception. An implicit measure was recently developed that assesses beliefs regarding past behaviour, referred to as the past nonsuicidal self-injury IAT (P-NSSI-IAT; Cathelyn et al., 2021). The P-NSSI-IAT follows the same procedure as the SI-IAT, with the exception that its stimuli consist of statements (regarding past NSSI behaviour) rather than single words or pictures. If participants respond faster on trials in which the same response key is used for categorizing statements that are inherently true (e.g., “I’m pressing computer keys”) and statements regarding past NSSI behaviour (e.g., “I have carved my skin on purpose”) than on trials in which the same response key is used for categorizing statements that are inherently false (e.g., “I’m climbing a mountain”) and statements regarding past NSSI behaviour, this might indicate that these individuals automatically endorse the belief that they have engaged in NSSI in the past. Two previous studies investigated the predictive utility of the P-NSSI-IAT and found that this measure discriminated well between participants who reported to have previously engaged in NSSI behaviour (i.e., cutting or carving of the skin)

and participants who reported to have never engaged in NSSI. P-NSSI-IAT scores also prospectively predicted NSSI behaviour over a clinically useful time-frame (i.e., one month; Franklin et al., 2017) and predicted this outcome above and beyond other known risk factors of NSSI (i.e., hopelessness, frequency of past NSSI, and prior suicidal thoughts).

Importantly, however, these studies were conducted in general online samples which were recruited through Prolific Academic (<https://www.prolific.co/>). To examine the clinical utility of the P-NSSI-IAT, it is important to investigate whether these previous findings generalize to a clinical population. In the current study, we will target outpatients and investigate (a) whether and (b) how well the P-NSSI-IAT discriminates between patients who report having recently engaged in NSSI behaviour (i.e., cutting or carving of the skin in the past year and past month) and patients who report having never engaged in NSSI behaviour. We will also examine (c) whether P-NSSI-IAT scores independently predict self-rated past year, past month, and future likelihood of NSSI, and (d) whether P-NSSI-IAT scores predict these outcomes above and beyond known risk factors of NSSI (i.e., gender, age, hopelessness, psychiatric disorders typically related to NSSI, and prior suicidal thoughts; e.g., Fox et al., 2015; Klonsky & Muehlenkamp, 2007). Note that the main aim of this study is to validate the P-NSSI-IAT by assessing its ability to detect prior NSSI behavior in a sample of clinical patients. For practical reasons, we do not assess the predictive validity of the P-NSSI-IAT. We include a future likelihood measure for exploratory purposes (see Cathelyn et al., 2021). Appendix A provides an overview of the research questions, hypotheses, sampling plan, analysis plan, and interpretations given different outcomes.

Method

Transparency and Ethics Statements

All materials, processing and analysis code, (pseudonymized) raw and processed data will be made publicly available on the Open Science Framework (xxx). The accepted protocol will be registered on the Open Science Framework (xxx). The study was approved by the UZ Gent Medical Ethics Committee (reference number 2022/3739). Informed consent will be obtained from all participants.

Participants

We will target patients who receive outpatient treatment for various conditions. Participants will be recruited through clinical psychologists in Flanders. We will contact clinicians through the Flemish Association for Clinical Psychologists, Facebook groups for licensed clinical psychologists, and a website where Flemish people can search for licensed clinical psychologists. Clinicians willing to collaborate will be asked to invite patients to participate in the study if (a) their first language is Dutch, (b) they are capable of conducting the study (i.e., not having a cognitive impairment and not being in serious crisis), and (c) they are between the age of 18 and 30 years. This latter inclusion criterion will be applied because NSSI behaviour is more prevalent in this age group than in older age groups (Swannell et al., 2014). The patients' eligibility to participate in the study will be evaluated by the clinicians. Participants will be reimbursed for their time and effort through a voucher (€10).

Xxx participants started the study. The data of participants will be excluded if they do not provide complete (questionnaire and/or P-NSSI-IAT) data. As recommended by Greenwald et al. (2003), the data of participants with response latencies of less than 300ms on 10% or more of critical P-NSSI-IAT trials will also be removed (xxx participants). We will also exclude the data of participants if P-NSSI-IAT error rates are above 30% across the entire task, and/or above 40% for any of the critical blocks (xxx participants). Note that we will apply these latter exclusion criteria for several reasons. First, the researchers will have minimal control over what participants are doing as the study will be conducted online.

Second, unlike the student participants who participated in most past IAT research, the participants in the current study will likely not be familiar with completing reaction time measures. As such, more participants might fail to adhere to instructions than in previous IAT studies. Third, the current sample will be relatively small thus there might be a stronger impact of outlier scores. Finally, participants in our study might be motivated to conceal their NSSI behaviour and thus try to alter their P-NSSI-IAT scores. Studies show that participants who try to alter their IAT scores tend to produce higher error rates (e.g., because they believe that increasing the number of errors is a valid faking strategy; e.g., Röhner et al., 2013; Steffens, 2004). However, for exploratory purposes, we will also conduct the analyses including the data of participants who meet the latter exclusion criteria and report whether doing so affects the results.

Further, we will also exclude the data of participants who cannot be assigned to the past year NSSI group or to the no history of NSSI group (xxx participants). This occurs when participants have not engaged in cutting of the skin in the past year, but did (a) engage in cutting of the skin more than a year ago, (b) use another NSSI method during their lifetime, and/or (c) attempt suicide using cutting of the skin as a method (because the category labels and items of the P-NSSI-IAT do not make a distinction between suicidal and non-suicidal self-injury). Relatedly, the data of participants will be excluded if there is uncertainty regarding their NSSI groups status because of inconsistencies in the self-report data, for example, when participants report having engaged in NSSI in the past month, but not in the past year (xxx participants).

The main effect of interest is the difference in P-NSSI-IAT scores between the past NSSI group and the no history of NSSI group. In line with our previous studies (Cathelyn et al., 2021), we will test differences in P-NSSI-IAT scores between individuals who have never engaged in NSSI on the one hand, and individuals who have engaged in NSSI on the other

hand. In the latter group, we will distinguish between individuals who have engaged in NSSI in the past year and individuals who have engaged in NSSI in the past month. Given that it will be more feasible to recruit a sufficient number of participants who have engaged in NSSI in the past year than a sufficient number of participants who have engaged in NSSI in the past month, the required sample sizes for the current study were calculated based on the estimated effect size for an independent samples *t*-test comparing P-NSSI-IAT scores from the past year NSSI group and the no history of NSSI group. Note that previous studies testing the predictive utility of implicit measures for NSSI typically focused on detecting lifetime prevalence of NSSI, but this may be less relevant for clinical purposes (Powers et al., 2020). We focus on more recent behaviour and will power the study to detect behaviour that is fairly recent and likely of clinical importance (i.e., NSSI in the past year). According to conventions for effect sizes (Cohen, 1988), in our previous studies, we obtained medium to large effect sizes when comparing P-NSSI-IAT scores between a past year NSSI group and a no history of NSSI group (with *ds* ranging from 0.68 to 0.82; Cathelyn et al., 2021). Given that previous studies have demonstrated that group differences between prediction scores for self-harm tend to be more modest in clinical than in community samples (Franklin et al., 2017; Sohn et al., 2021), we applied an estimated effect of $d = .60$ in the power analysis which is slightly smaller than the lowest observed effect size.

Results of the power analysis showed that a total of 146 participants would allow for detecting the estimated effect size with 85% power in a one-tailed *t*-test ($\alpha = .05$) with an estimated group-allocation ratio (i.e., the proportion of cases and controls) equal to 5 (i.e., 24 cases and 122 controls). Because our previous studies were conducted in general online samples and we conducted pre-screening studies to recruit a large number of cases, we could not base the estimated group-allocation ratio on our previous studies. Therefore, we chose to apply a conservative estimate of the group allocation ratio in the power analysis. Of course, it

is possible that we will recruit more than 24 cases but in this case, the statistical power will be higher than planned. We will stop data collection when 146 participants have fully completed the study.

The final sample size consisted of xxx participants ($M_{\text{age}} = \text{xxx}$, $SD_{\text{age}} = \text{xxx}$; xxx% male, xxx% female, xxx% other identity), including xxx participants who engaged in NSSI in the past year and xxx participants without a history of NSSI. These sample sizes provided us with xxx% power to detect an effect size of $d = \text{xxx}$. Participants from the past NSSI group reported to have engaged xxx times in cutting of the skin on average ($SD = \text{xxx}$). Presence of psychiatric diagnoses was observed in xxx% of the participants, including xxx% participants with a mood disorder, xxx% participants with an anxiety disorder, xxx% participants with an eating disorder, and xxx% participants with a substance abuse disorder.

Materials and Apparatus

The study was built using lab.js, a tool for creating browser-based studies. The study will be hosted online. Participants will receive a link to the study via their treating clinician and will be asked to complete the study using their laptop or desktop. All materials are translated to Dutch using back-translation, except for the Patient Health Questionnaire (PHQ; Spitzer, 1999). We will use the Dutch version of the PHQ as translated by the MAPI Research Institute (see <https://www.phqscreeners.com/>).

P-NSSI-IAT

The P-NSSI-IAT will follow the same procedure as in previous studies (Cathelyn et al., 2021). Participants will be instructed to categorize statements regarding past (non-) NSSI behaviour and statements that are inherently true or false as fast as possible using the E- or I-key on the keyboard. On each trial, a statement will appear in the middle of the screen until participants press one of the valid response keys. If the response is correct, the statement will

disappear, and the next statement will be presented 400ms later. If the response is incorrect, a red cross will replace the statement for 200ms, and the next statement will appear 400ms after the red cross appeared. Category labels will be presented in the top left and right corners of the screen to aid categorization. The category labels and stimuli are listed in Appendix B. We will use the font Helvetica with font size 15 for the category labels and font size 18 for the statements. The category labels will be presented in upper case letters, and the statements will be presented in lower case letters. The P-NSSI-IAT procedure will be presented full screen.

The P-NSSI-IAT consists of seven blocks and 192 trials. Before the start of the first block, participants will receive the following instructions regarding speed and accuracy of responding: “Please respond AS QUICKLY AS POSSIBLE, while at the same time, trying not to make too many mistakes (some mistakes are OK). [...] Avoid all distractions and pay attention. Try to answer as quickly as possible! Keep your fingers on the E and I keys at all times, in order to respond faster.” Before the start of all subsequent blocks, participants will be reminded to try to respond as quickly as possible. Participants will be able to proceed to the next block by pressing the space bar.

In the first block of the P-NSSI-IAT, participants will practice categorizing four statements regarding past NSSI behaviour (e.g., “I have carved my skin on purpose”) using the E-key, and four statements regarding past non-NSSI behaviour (e.g., “I have carved my skin not once”) using the I-key. In the second block, participants will practice categorizing four statements that are inherently true (e.g., “I’m pressing computer keys”) using the E-key, and four statements that are inherently false (e.g., “I’m playing football”) using the I-key. Both practice blocks will consist of 32 trials during which the eight statements will each be presented four times. In a next two block, participants will categorize statements from all four categories simultaneously using the practiced key assignment (i.e., the E-key for sentences regarding past NSSI behaviour and statements that are inherently true, and the I-key for

sentences regarding past non-NSSI behaviour and sentences that are inherently false). In the combined blocks (16 and 32 trials) the 16 statements will each be presented three times. Following this, there will be another practice block in which only statements regarding past (non-) NSSI behaviour need to be categorized, but this time with the response key assignment reversed (i.e., the E-key for statements regarding past non-NSSI behaviour and the I-key for statements regarding past NSSI behaviour). This practice block will consist of 32 trials during which the eight statements will each be presented four times. In the final two combined blocks, participants will need to categorize statements from all four categories using the new response key assignment. The order of the trials will be determined randomly for each block and participant.

Self-Report Measures of NSSI Behaviour

To assess the outcome variables of interest, participants will be asked how many times they have intentionally cut or carved their skin without intending to kill themselves in the past 12 months and the past 30 days. These two questions will be rated on a scale ranging from 0 to 10+ times. Participants will also be asked to indicate how likely they would be to intentionally cut or carve their skin without intending to kill themselves in the future. This question will be rated on a Likert scale ranging from 0 (*low/little*) to 4 (*very much/severe*).

To determine whether the data of participants should be excluded (see exclusion criteria), participants will also be asked about lifetime cutting of the skin with and without the intention to kill themselves, and lifetime NSSI using any other method. Participants will be asked to indicate “yes” or “no” when answering these questions. All of the questions regarding NSSI behaviour were based on or adapted from the Deliberate Self-Harm Inventory (DSHI; Gratz, 2001) and the Self-Injuries Thoughts and Behavior Interview (SITBI; Nock et al., 2007).

295 *Measures of Risk Factors*

296 Psychiatric diagnosis will be assessed using the PHQ. The PHQ is a self-administered
297 questionnaire that assesses the presence of five common types of psychiatric disorders: mood,
298 anxiety, eating, substance abuse, and somatoform disorders. Note that we will only include
299 the first four modules of the questionnaire because these disorders are typically related to
300 NSSI (e.g., Klonsky & Muehlenkamp, 2007). Hopelessness will be assessed using the Beck
301 Hopelessness Scale (BHS; Beck et al., 1974). The BHS assesses positive and negative beliefs
302 about the future and consists of 20 items (e.g., “my future seems dark to me). Participants will
303 be asked to evaluate these statements as true or false. Finally, frequency of prior suicidal
304 thoughts will be assessed through a question that was adapted from the SITBI: “during how
305 many separate times in your life have you had thoughts of killing yourself?”. Participants will
306 indicate this frequency on a scale ranging from 0 to 10+ times.

307 **Procedure**

308 After providing informed consent, participants will indicate their age and gender and
309 will complete the P-NSSI-IAT. Afterwards, participants will be reminded about the
310 anonymous nature of our study (to reduce socially desirable responding) and answer the
311 questions regarding NSSI behaviour. In the next phase, participants will complete the PHQ,
312 the BHS, and will be asked about prior suicidal thoughts. At the end of the study, participants
313 will be referred to several help sources for coping with NSSI and suicidal thoughts and
314 behaviour. Participants will also be referred to a separate website where they will be asked to
315 provide us with the information we need for compensation purposes.

316 **Data Pre-Processing**

317 To calculate P-NSSI-IAT scores we will use the D4 scoring algorithm (Greenwald et
318 al., 2003). This algorithm assesses the difference in reaction times between the first two and

second two combined blocks while correcting the latencies for individual variability. In line with this algorithm, trials with latencies longer than 10.000ms will be removed and latencies on trials with an incorrect response will be replaced with the participant's block mean (based on correct responses) plus a 600ms penalty. Reaction times on trials of the first two combined blocks will be subtracted from reaction times on trials of the second two combined blocks, such that higher scores indicate faster responding during combined blocks in which statements regarding past NSSI behaviour and statements that are logically true share the same response key. The Spearman-Brown corrected split-half reliability for the P-NSSI-IAT was xxx. The presence of any mood, anxiety, eating or substance abuse disorder will be determined using the manual and scoring instructions for the PHQ (Spitzer, 1999). No distinction will be made between specific types of these disorders (e.g., major depressive disorder, other depressive syndrome, etc.). If any (or more) of the specific disorder types (e.g., major depressive disorder) is (are) present, the variable for the overarching disorder (e.g., mood disorder) will be scored as "1", otherwise it will be scored as "0". The Cronbach's alpha for the modules of the PHQ were xxx (mood disorders), xxx (anxiety disorders), xxx (eating disorders), and xxx (substance abuse disorders). Answers that indicate hopelessness on the BHS will be scored as "1". Total scores for the BHS will be obtained by summing the item scores and higher scores indicate more hopelessness (Cronbach's alpha = xxx).

To assign participants to the NSSI groups, we will use the self-reported NSSI frequencies and ratings. Table 1 provides an overview of the criteria for the self-report questions that will be used to assign participants to the NSSI groups and will include the number of participants per NSSI group.

Table 1

Grouping of Participants and Number of Participants per NSSI Group

Group	<i>n</i>	NSSI frequencies and ratings		
		Past year	Past month	future likelihood
		NSSI	NSSI	NSSI
Past year NSSI group	xxx	> 0	= 0 or > 0	-
Past month NSSI group	xxx	> 0	> 0	-
No history of NSSI group	xxx	= 0	= 0	-
Low future likelihood NSSI group	xxx	= 0 or > 0	= 0 or > 0	0 – 2
High future likelihood NSSI group	xxx	= 0 or > 0	= 0 or > 0	3 – 4

Note. NSSI = nonsuicidal self-injury.

Data Analysis-Plan

To test whether the P-NSSI-IAT can distinguish between participants with and without a history of NSSI, we will conduct independent samples *t*-tests. We will conduct two separate *t*-tests: one for comparing P-NSSI-IAT scores between participants without a history of NSSI and participants who have engaged in NSSI in the past year, and one for comparing P-NSSI-IAT scores between participants without a history of NSSI and participants who have engaged in NSSI in the past month.

To determine how well P-NSSI-IAT scores discriminate between these groups, we will conduct receiver-operating-characteristic (ROC) analyses. More specifically, we will calculate the Area Under the Curve (AUC), sensitivity, and specificity of the P-NSSI-IAT for detecting past NSSI. In previous studies (Cathelyn et al., 2021) we established cut-off scores for the P-NSSI-IAT to maximize sensitivity (0.16) or specificity (0.65) while retaining fair specificity and sensitivity, respectively. We will test whether these thresholds remain meaningful in the current sample. We will also report these values when the cut-off of P-NSSI-IAT scores is set at zero because this cut-off is typically considered to be theoretically relevant (Cvencek et al., 2021).

To test the ability of the P-NSSI-IAT to independently predict past NSSI and self-rated future likelihood of NSSI, we will test three separate logistic regression models (i.e., one

model for the prediction of past year NSSI, one model for the prediction of past month NSSI, and one model for the prediction of self-rated future likelihood of NSSI). Finally, to test the ability of the P-NSSI-IAT to incrementally predict past year NSSI, past month NSSI, and self-rated future likelihood of NSSI, we will conduct hierarchical logistic regression analyses for each of the outcomes. Risk factors that are significantly associated with the outcomes will be entered in a first step and P-NSSI-IAT scores will be added in a second step. We will conduct a likelihood ratio test to examine whether there is a statistical difference between the nested models. Please note that if the sample size is too small for one (of the levels) of the factors (e.g., if, for gender, only a few participants report identifying themselves with something other than male or female or only a few participants meet the criteria for an eating disorder), this could result in an unreliable model fit (resulting in extremely wide confidence intervals for the effect sizes) and problems when fitting the logistic regression models. If this is the case, we will exclude (that level of) that factor for these specific analyses.

Anticipated Timeline

Data collection will start after in principal acceptance of the Stage 1 Registered Report and is estimated to last at least 4 months. However, given the targeted population, data collection may last longer. Data analysis and preparation of the final manuscript are expected to be finished 6 months after data collection has finished.

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