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Masterarbeit / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„The relatedness of nonsuicidal self-injury and suicide attempts, within the frame of the interpersonal theory of suicide, a meta-analysis and systematic review."

verfasst von / submitted by

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Contents

Abstract

Self-injury is a highly prevalent behaviour in its nonsuicidal version and in its suicidal version, a major causes of death. Even so, up to this day no nomenclature exists, to distinguish between these two behaviours - beyond the intention to die.

To explore the possibility to distinguish self-injury beyond the intention do die, in this meta-analysis the Interpersonal theory of suicide was used as a proxy nomenclature, to observe how nonsuicidal self-injury relates to suicide attempts. The focus of this analysis was the moderation quality of nonsuicidal self-injury on the relation of suicide ideation and suicide attempts, compared to the models proposed moderator 'acquired capability for suicide scale'. Furthermore it is investigated if the model estimations differed, when nonsuicidal self-injury is used, in the functional role of suicide attempt, in general and if the moderators for acquired capability for suicide scales are applied.

Results: Nonsuicidal self-injury showed itself, with R^2 =17 , as a good moderator, but the acquired capability for suicide scale was superior with R^2=36, the model estimations did not differ differ, when using suicidal self-injury instead of suicide attempt. As the model was not capable to distinguish between nonsuicidal self injury and suicide attempts, it can be stated that the relation of suicide ideation, non suicidal self injury and suicide attempt is more complex then the categorical categorization reflects and is not properly represented by a simple moderation or mediation relationship.

Keywords: Interpersonal theory of suicide; Meta-analysis; Structural equation modelling; MASEM; Nonsuicidal self-injury; Suicide; Suicide attempt; Suicide ideation.

Abstract (Deutsch)

Selbstverletzendes Verhalten ist ein hoch prävalentes Phänomen, in seiner nicht suizidalen Version und in seiner suizidalen Ausformung, eine der führenden Todesursachen. Trotzdem gibt es bis heute keine Nomenklatur für dieses Verhalten, es ist unklar, woran beide Verhaltensformen unterschieden werden können – abgesehen von der Intention zu sterben.

Um die Möglichkeit selbstverletzende Verhaltensformen zu unterscheiden, auf Basis von mehr als Intention zu unterscheiden, wird in dieser Metaanalyse die ‘interpersonale Theorie des Suizids’ als proxy Nomenklatur verwendet. Dabei war der Fokus auf der Moderatorqualität von non suizidalem selbstverletzendem Verhalten zum Verhältnis zwischen Suizidideation und Suizidversuchen. Dies wurde verglichen mit den Moderatorqualitäten der für das Modell konzipierten Messskalen der 'acquired capability for suicide scales'. Weiter wurde untersucht, ob sich die Modell-Schätzer unterscheiden, wenn non suizidales selbstverletzendes Verhalten die Position von Suizidversuchen im Modell einnimmt; sowohl allgemein, als auch im Bezug auf die Moderatorqualität der konzipierten Messskalen.

Nicht-suizidales selbstverletzendes Verhalten hat sich im Modell als guter Moderator gezeigt (R^2=17), wobei die konzipierte Skala für 'acquired capability for suicide' bessere Moderatorqualitäten hatte (R^2 = 36). Non suizidales selbstverletzendes Verhalten anstelle von Suizidversuchen in das Modell einzufügen hatte keinen signifikanten Einfluss auf die Schätzwerte des Modells. Da das Modell keinen Unterschied zwischen suizidalem selbstverletzenden Verhalten und nonsuizidalem selbstverletzenden Verhalten erfassen konnte, zeigt sich das Verhältnis von Suizidideation, Suizidversuchen und nonsuizidalen selbstverletzendem Verhalten als komplexer, denn ein klar kategorisches oder Moderator/Mediator Verhältnis.

Keywords: Interpersonale Theorie des Suizids, Metaanalyse, Strukturgleichungsmodell, MASEM, Nonsuizidales selbstverletzendes Verhalten, Suizidversuche, Suizidideation.

Introduction

Suicide

Suicide, the act of deliberately killing oneself, is with around 800,000 cases each year, a major cause of death and in the age bracket of 15–29 years even the second cause of death (World Health Organisation, 2014).

In light of this prevalence, that only 80 countries are rated by the World Health Organisation (WHO) as providing good data quality and 38 countries, as having national suicide prevention programs (World Health Organisation, 2014); the efforts undertaken to prevent suicide seem – small, when compared to the efforts undertaken to prevent organized violence (e.g., war, terrorism . . .), which accounted for ~76,000 deaths 2018 (Pettersson, Högbladh, & Öberg, 2019). Poignant, when seen like this: Should the WHO goal to reduce suicide by 10% (World Health Organisation, 2013) until 2020 succeed, a comparable amount of life would have been saved, than by preventing all reported organized violence.

Currently the ability of clinicians to predict suicide is questionable (Large, Sharma, Cannon, Ryan, & Nielssen, 2011) -while around 80% suicide victims visit primary health care, in the year prior to their death (Stene-Larsen & Reneflot, 2019)- any advancement to our understanding of suicide and ability to recognize and intervene becomes a matter of public relevance. Made poignant by the fact that -even in light of the high number of suicide cases- suicide still has no nomenclature, even though this has been stated necessary many times (American Psychiatric Association, 2013; Silverman, Berman, Sanddal, O'Carroll, & Joiner, 2007). In a field in which data can be collected only to a limited degree (Silverman & De Leo, 2016), as individuals who committed suicide elude available methods.

The proxy suicide attempt. "Suicide attempt is a self-initiated sequence of behaviours by an individual who, at the time of initiation, expected that the set of actions would lead to his or her own death." (American Psychiatric Association, 2013, p. 801) or in short: A behaviour, with an intent to die. Is the best proxy for committed suicide, as suicide attempts are the best predictor for future suicide (Bergen et al., 2012; Carroll, Metcalfe, & Gunnell, 2014).

With attempted suicide and completed suicide seemingly having both common and distinct risk factors (Haukka, Suominen, Partonen, & Lonnqvist, 2008), as well as systematic differences (Batty et al., 2018), between the population of suicide attempters and those who completed suicide; an example being the sex-paradox of suicide: Men commit the majority of all suicides, but women attempt the majority of suicides (Cha et al., 2018). These systematic differences are important as

suicide attempts are 21.73 times more likely to occur, than completed suicide - USA sample (Olfson, Blanco, et al., 2017; World Health Organisation, 2014).

With both the prevalence for suicide attempts and completed suicide ranging considerably, depending on the country and specific group in question, e.g. prisoners (Favril, Wittouck, Audenaert, & Vander Laenen, 2019), military personal (Chu, Hom, Stanley, et al., 2018), and Chinese middle school students (Ai, Xu, Li, & Li, 2017), reporting prevalences notably higher, than those in the respective general population. All this contributes to the complex relationship between suicide attempts and completed suicide. Though these differences also show: When cases of suicide in a population are more numerous, so are suicide attempts - implying a strong common element.

As not only suicide misses a nomenclature, but suicide attempt - to a degree- also misses such a nomenclature (World Health Organization, 2016, p.57-58), comparisons and aggregation of data is difficult (Posner, Oquendo, Gould, Stanley, & Davies, 2007; Silverman et al., 2007). A fact, further complicated by the commonly used definition of suicide attempts, as self-harm, with some suicidal intent. A correct record, relies on the honesty and recollection ability of the attempter and is impacted by the interpretation of the medical staff, overall limiting quality. This limitation stems from mixing suicidal behaviour, with the phenomenological related behaviour of self-harm, without suicide intent; as self-harming behaviour without intention to die – often named: Nonsuicidal self-injury (NSSI) – is highly prevalent (Plener, Schumacher, Munz, & Groschwitz, 2015) and can, when the intention is ambiguous, be confused with suicidal behaviour (DSM-5, p.805, 2013).

As such studies including NSSI, when studying suicide attempts and efforts to distinguish both by comparing co-morbidities, co-occurrences and psychological correlates (Pompili et al., 2015; Posner et al., 2007), became more common. To improve this convoluted situation the DSM-5 also proposed the NSSI-disorder (American Psychiatric Association, 2013, p.803) and the suicidal behaviour disorder (American Psychiatric Association, 2013, p.801) in the section of 'conditions for further study.' Luckily this has lead to a large number of studies using these proposed definitions, which enables quantitative data synthesis of both NSSI and suicide attempts.

Self-harm and NSSI

Self-harm, intentional harming of ones own body, is the broadest possible definition of self-harm and elicits numerous understandings, e.g. indirect self-harm (St. Germain & Hooley, 2012); but in regard to a difference between suicide attempts (SA) and NSSI, two broad views can be observed, both differing in their core assumptions: One view is that NSSI and suicide attempts differ qualitatively (Butler & Malone, 2013; Hamza, Stewart, & Willoughby, 2012; Muehlenkamp,

2014; Nock, 2010). The main difference between the two is the function of the act: With an intent to (re-)gain control (Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007), among other functions like anti-dissociation, anti-suicide and interpersonal-influence (Lonsky, 2007), for NSSI. And to achieve death, for suicide attempts. Main reference for this view is the DSM-5 proposing such a distinction in the section of conditions for further study (American Psychiatric Association, 2013, p.801-806). Supporting studies found relational differences, such as: Self-harming behaviour items loading on two factors, one NSSI and one suicidal factor (Evans & Simms, 2019).

The other view is that NSSI and suicide attempts are not qualitative different, just: self-harm, on a continuum, (Bergen et al., 2012; Carroll et al., 2014), the main reference being the terminologies used within WHO publications (World Health Organization, 2016). Supporting studies found that NSSI is one of the best predictors for future suicide attempts (Victor & Klonsky, 2014) and that one function of self-harm is to not commit suicide (Klonsky, 2007).

The two views of understanding self-harm are not exclusive to one another, but note the differing degrees of distinction and goals, stemming from the focus of research underpinning DSM immanent research and WHO reports respectively. While the DSM is focused on establishing and evaluating diagnostic categories and disorders, the WHO is interested in surveillance of large populations: The decision of discriminating phenomenologically related behaviours like NSSI and self-harm, is the result of those foci. Effectively, WHO orientated publications use self-harm, often regardless of intention and citing publications supporting such a view and DSM-5 oriented work citing publications supporting the NSSI view.

Which view has the broader support, is hard to determine, due to the fuzzy nature of these and the large amount of studies, on the whole. But in general: If a researcher is focused on questions typically associated with the DSM, the researcher will observe that the NSSI terminology is dominant, with only some researchers still using the term self-harm. A researcher mainly interested in questions typically associated with the WHO, will likely see NSSI as over identifying for his/her research and just aggregate the term under self-harm.

Knowledge of these two groups is key, for the current meta-analysis, as empirical work based on the second view could contribute studies that use self-harm, meaning both attempts and NSSI: it must be assured that such studies are not included in the current meta-analysis. For the research field of suicide, the main downside is the loss of a common understanding, as well as a general loss of information.

Moreover, it is of utmost importance for any researcher to always explicitly state his understanding of self-harm and observe how self-harm is understood in any study he/she reads, as it

cannot be assumed that a another researcher understands self-harm the same way.

Self-harm: How it is understood here. Nonsuicidal self-injury, is defined as self-injury, without the intention to die.

While acknowledging, that its measurement can be confounded by suicide attempts, due to potential misremembering and misreporting, as the likelihood for suicide attempts, in NSSI afflicted individuals is elevated (Georgiades et al., 2019; Olfson, Wall, et al., 2017).

The term self-harm, is only used, when directly referring to the theoretical work underpinning the model, being Joiners (2005) book, in which the term self-harm is used, remaining unclear about the intention; the studies predominantly use NSSI. This discrepancy is a result of Joiners book being published before the term NSSI was widespread, while the empirical literature investigating it being published mostly after the DSM-5 section of conditions for further study was announced; as the implementable path-model was developed and published 2010, by van Orden et al. (2010).

Since any confusion in terminology is problematic, here the following applies: Self-harm is used, when it remains unclear, if the original author differentiated, based on suicidal intent or when discussing Joiners book specifically (Joiner, 2005). Should the author of a paper use the term self-harm, but remarks it as self-harm without suicidal intent, the term NSSI is used.

The Interpersonal Theory of Suicide

The fact that suicide attempts remain the best proxy for completed suicide despite systematic differences to completed suicide, shows the complex nature inherent in suicide research and represents an example for the research field lacking a nomenclature. One way to handle the missing nomenclature is the usage of theoretically founded models or concepts, here *the Interpersonal Theory of Suicide* (IPTS) (Joiner, 2005; Van Orden et al., 2010).

The IPTS was chosen for multiple reasons, beginning with it being the first desire–capability theory, meaning it both tries to explain how suicidal ideation begins to form and how suicidal ideation can lead to suicide (attempts) and not just explain why people are 'suicidal' (Klonsky & May, 2014). According to the IPTS two factors represent the basis for suicide ideation, (a) the experience that one is failing to belong (*thwarted belongingness*), and (b) the experience that one is a burden to others (*perceived burdensomeness*). Only if both factors are experienced, an individual develops suicidal ideation and only if a person sees no hope for a change, active suicidal ideation occurs. Should any change be likely or only thwarted belongingness or perceived burdensomeness

persist, no suicidal ideation occurs, or only passive suicidal ideation.

Individuals experiencing active suicidal ideation can then further be split in two groups: (a) Those with the capability to enact their ideation and (b) those who are not able to do so.
The focus of this meta-analysis is the second split exploring to which degree NSSI can explain the difference between those able to enact their ideation and those who are not able to do so.

Investigating this is possible, due to the IPTS development stages. In the initial stage, marked by the book: "Why do people die by suicide" (Joiner, 2005), self-harm is used as main moderator. In the second stage, *the acquired capability for suicide scale* (Ribeiro et al., 2014; Van Orden, Witte, Gordon, Bender, & Joiner, 2008) was developed, as a specific moderator.

Concluding, that studies exist that use the developed acquired capability for suicide scale and studies exist that use NSSI as a measurement for the capability to commit suicide. Providing sufficient data for a meta-analysis and allowing a direct comparison between the effectiveness of NSSI and the the developed scale for acquired capability for suicide (Gauthier, Hollingsworth, & Bagge, 2018), as operationalization of the capability to commit suicide.

Operationalized by using the acquired capability for suicide scale and/or NSSI as moderators of the variance, between suicide attempts and suicide ideation (Matney et al., 2018), set within a simplified version of the path-model proposed by van Orden (2010); depicted in figure 1.

Figure 1. Simplified path-model used for analysis

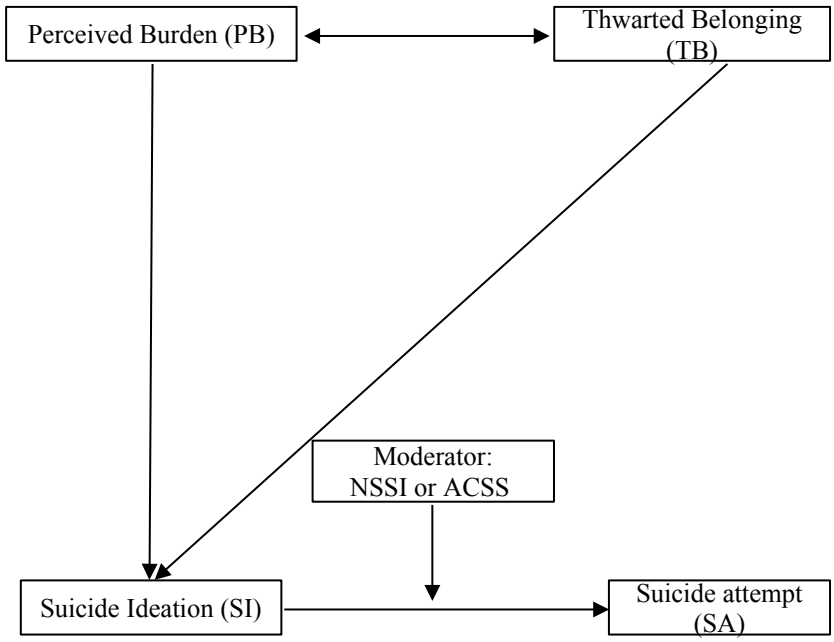


Figure 1. Simplified path-model, only variance specific moderators are depicted, moderators age and sex are additionally applied on all variances; NSSI = Non suicidal self injury; ACSS = Acquired capability for suicide scale

Note that in *all figures:* Perceived burdensomeness is shortened to 'Perceived Burden' and

Thwarted belongingness is shortened to 'Thwarted belonging'. This is purely for formatting reasons; it is not implying difference.

All used scales have validation studies supporting them (Ribeiro et al., 2014; Rimkeviciene, Hawgood, O'Gorman, & De Leo, 2017; Van Orden, Cukrowicz, Witte, & Joiner, 2012; Van Orden et al., 2008).

Additionally to these variance specific moderators, the moderation quality of sex and age has been investigated; as studies were observed, that reported: Suicide indicators in general (Boeninger, Masyn, Feldman, & Conger, 2010), as well as suicide ideation (Chin, Lee, & So, 2011; Dennis et al., 2007), suicide attempts (Lewinsohn, Rohde, Seeley, & Baldwin, 2001) and NSSI (Andover, Primack, Gibb, & Pepper, 2010; Plener et al., 2015) being impacted by sex and age.

Interpersonal needs questioner (INQ)

Thwarted belongingness & perceived burdensomeness. Thwarted belongingness and perceived burdensomeness are the two sub scales of the *Interpersonal needs questioner (INQ)* (Van Orden et al., 2010). The INQ generally supported and evaluates the probability of suicide ideation and general suicide risk (Chu, Buchman-Schmitt, et al., 2017; Ma, Batterham, Calear, & Han, 2016). The number of items varies between 5 and 25, but all forms measure the same concept (Hill et al., 2015).

Accordingly "Thwarted belongingness is a psychologically-painful mental state that results when fundamental need for connectedness is unmet" (Van Orden et al., 2012).

If the need for connectedness remains unmet, if loneliness, isolation and low social support persists, thwarted belongingness emerges. The mean Cronbach alpha of the thwarted belongingness scale in all studies meta-analysed was .88.

Perceived burdensomeness is to perceive oneself as a burden to others, *not* to be confused with being burdened and not the reality of burden is relevant, but the perception of being a burden (Joiner, 2005, p.98f.). The mean Cronbach alpha of the perceived burdensomeness scale in all studies meta-analysed was .91.

As, On the one hand in a number of primary studies exist, discussing the necessity to include thwarted belongingness, as perceived burdensomeness showed itself as the superior predictor for suicide ideation (Bryan, Clemans, & Hernandez, 2012; Mitchell, Brown, Roush, Tucker, et al., 2019). As well as, on the other hand, the contradictory discussion in other studies: Thwarted belongingness being the better predictor for suicide ideation (Monteith, Pease, Forster, Homaifar, & Bahraini, 2015). Due to this the discussions observed was included, operationalized by excluding

both scales from the model once and then inspect both alternative models, regarding: (a) a difference in model estimation and (b) a reduction in the modelled variance to suicide ideation.

Acquired capability for suicide scale. The acquired capability for suicide scale was developed to measure the ability, of a person, to commit suicide.

Currently two scales exist that measure this ability: (a) the original acquired capability for suicide scale (Van Orden et al., 2008), and (b) its revision, the *fearlessness about death scale* (Ribeiro et al., 2014). The mean Cronbach alpha of all studies meta-analysed was .79, for the original scale and .80 for the fearlessness about death scale.

Rimkeviciene (2017) investigated these scales to their discriminant capabilities using a CFA and found that only the 20 item version of the original acquired capability for suicide scale was able to distinguish NSSI and suicide attempts and only if set up in five *factors*. Versions with different item counts and the revised seven item fearlessness about death scale (Ribeiro et al., 2014), had larger explanatory power for NSSI, than suicide attempts; or just dropped below an adequate *model fit* in general, when used to distinguish NSSI and suicide attempts.

These five factors are: Fearlessness about death, enjoyment of observed violence, insensitivity to sight of blood, fearlessness about dying and general fearlessness (Rimkeviciene et al., 2017).

Due to these observations, the original scale and the revision are not aggregated, but treated as different. Moreover a additional analysis in implemented, in which nonsuicidal self-injury is placed as the outcome variable, instead of suicide attempts. If possible then the two acquired capability for suicide scales are applied as moderators to the variance of suicide ideation and nonsuicidal self-injury.

Self Harm in the IPTS. In the original work of Joiner (2005) self-harm had a major role in explaining the difference between a individual only thinking about killing themself and killing themself, self-harm being the training to commit suicide, as it is not easy to kill oneself.

Without such training, the acquired capability would be missing and even a strong intention to die would not result in suicide, so Joiner (2005).

Self-harm here is to be understood as NSSI and attempted suicides. With ‘successful attempts’ being described as somewhat qualitatively different, then attempted suicide (Joiner, 2005, p. 57f.). Due to data availability only suicide attempts can be used as outcome, the impact – of this discrepancy – to validity on the current analysis and the emerging results must be referred to in the discussion. Regardless of the intention to die, the mere training is one risk factor of self-harm (Joiner 2005, p.56).

Suicide attempts. Suicide attempts are the outcome variable of the path model. NSSI might be put in its place, to investigate the discrimination capability of the acquired capability for suicide scale, between NSSI and suicide attempts, given ideation.

Hypotheses

Hypotheses are investigated within the simplified path model of van Orden et. al. (2010), (see figure 1), if not noted otherwise.

(1): Moderators age and sex, both, if measured together, as well as independent parameters have a significant moderation effect on the model.

(2): The moderating effect of the acquired capability for suicide differs between the original and the revised version of the scale.

(3): The moderating effect of NSSI is significantly higher on the variance between suicide ideation and suicide attempt than the moderating effect of the acquired capability for suicide scale.

(4): The moderation effect of the acquired capability for suicide scale differs depending on its application on the variance between suicide ideation and attempt, or suicide ideation and nonsuicidal self-injury.

(5): The exclusion of either thwarted belongingness or perceived burdensomeness, leads to diminished predictive capabilities for suicide ideation and reduced model fit estimations of the IPTS These diminishing effects are moderated by sex and age.

Disclosure, regarding Pre-Registration

Pre-registration was not possible, due to long waiting periods in Prospero; first registration taking about 3-4 months. This, combined with the insufficient set-up of Prospero for the type of meta-analysis implemented here lead to pre-registration failing.
As pre-registration failed, a Pre-Registered Report (PRR) was submitted to the supervisor; with the goal the at least emulate the purpose of a pre-Registertation; this was done before any data was calculated and included: introduction and methods.

While the introduction of this pre-registered report is comparable to the introduction of the final work, the method section had to be changed, as limitations emerged, that were not known before the procedure was implemented, mainly due to limitations in data availability and resources. Further additions had to be made in a final phase, to ensure ease of reading, which introduced further sub-analysis and explanations. Between the pre-registered report and the final version: Hypotheses 1 to 3 remain unchanged, while hypotheses 4 and 5 were changed regarding the indicators used for validating the hypotheses. No directions and subject matters were changed; these adaption were necessary, due to still evolving understanding of the method at hand.

Methods

Systematic search

Inclusion criteria. For a study to be included, the Interpersonal theory of suicide has to be applied to investigate one or more of the following variables: Nonsuicidal self-injury, suicidal ideation and suicide attempts. Data must be reported in a correlation matrix. Contrary, correlations not reported in correlation matrices cannot be included. No restrictions are applied on publication status, only literature in English language is included.

The search process. To achieve a representative sample of studies, Web of Science (WOS) and Google Scholar were systematically searched in two steps, with the goal to locate all applicable studies; applying a general systematic search followed by a forward forward citation search.

The general systematic search. Used to locate all literature and to check the assumed citation basis for the forward search the search string were:

1.) “thwarted belongingness” “suicide attempt” “perceived burdensomeness” “suicide ideation”“Self harm” OR “Self Injury” OR “self Mutilation” OR NSSI OR “self directed violence” OR “Non suicidal self injury” “Interpersonal theory of suicide”, for Google Scholar.

2.) “TS=(((”Self Harm* " OR “Self inj*” OR “Self mutilation” OR NSSI*) AND (“suicid* ideation” OR suicid* OR “suicid* attempt”)) AND ((Interpersonal NEAR “Theory of suicide”) OR (“thwarted belongingness” and “perceived burdensomeness”)))", for WOS.

All studies found were saved, according to the search process – a research protocol including dates and the number of studies found per page, is available on request. As Google Scholar has a search order based on relevance, which might change between searches, the Google

Scholar search was split up according to publication years – every year being searched in one session to evade the problem of changing relevancy between sessions.

After both Web of Science and Google Scholar were searched, emerging studies were split, based on reporting or not reporting correlation matrices.

Those without correlation matrices were excluded. In those including correlations-matrices, the assumption was checked, that all studies had to cite Joiner (2005) or van Orden et al. (2010), which was the case. Moreover, oddly Joiners book was noted by Google as having the publication year 2007, while linking to the 2005 version. No clear reason for this emerged.

Based on the validated assumption the forward citation search was implemented, the search was based on Joiner's book (2005) and van Orden et. al. (2010) peer reviewed paper. As described before the Google Scholar search was split by years. The search strings for these searches were:

1.) "TS=(((”Self Harm* "OR”Self inj*" OR "Self mutilation" OR NSSI*) AND ("suicid* ideation" OR suicid* OR "suicid* attempt"))", for WOS.

2.) "suicide attempt" "suicide ideation" "Self harm" OR "Self Injury" OR "self Mutilation" OR NSSI OR "self directed violence" OR "Non suicidal self injury", for Google Scholar.

Only the forward citation searches were repeated, to include any new literature, as it was established that every paper and thesis either cited Joiner or van Orden. The general search has been preformed between the 9.4.2019 and 24.04.2019. The search was updated on the 10.11.2019, leading to the inclusion of four additional studies.

Exclusion criteria & excluded data. Since no restriction on publication status was applied, a number of duplicates emerged, mainly thesis that later were also published as papers. In such a case, the thesis were treated as duplicate and were removed. Further exclusions were evaluated at two points in time and only done if at both time points the study was rated as necessitating exclusion.

The most prominent reason to exclude studies was the usage of the IPTS as one of many supporting theories for observation. The next major reason for exclusion was suicide being measured under the general term *suicide risk*, aggregating suicide ideation, suicide attempts and/or NSSI. To be excluded, a scale must have been used, that mixed at least two terms and reported these as such, not separated in possible sub-scales. An example – to this – is the *suicide behaviour questioner- Revised* (Osman et al., 2001). The questioner measures suicide attempts and suicide ideation on sub-scales and can report these accordingly, or as a combined score. A study is excluded, if only the combined score is reported. Moreover, during analysis all non-positive definite matrices were excluded – using the metaSEM function '*is.pd()*'; as these (i.a.) include

illogical elements (Wothke, 1993; Sheng, Kong, Cortina, & Hou, 2016).

Finally, Fox (2016) reported a mean for the revised version of the acquired capability scale of 36.72, even though the possible range of the scale is 0 - 28.

This inonstistent data entry is likely a result of using the original scale for acquired capability for suicide, for which a mean of 36.72 can be expected, but noting the revised version. This data entry was excluded, all other data from the study was included. For further reasons of exclusion see flow cart (figure 2).

Data extraction, coding and preparation. Study coding was done using excel. Tables were separated. One each for all parameters and one each for all correlation matrices. Backups of these exist, for each step of data preparation. For an overview of all original coding items see Appendix A.

After extraction, data availability of potential moderators had been investigated. Based on data availability and the defined hypotheses, coded items were excluded that did not fulfil a central role, or did not report sufficient data, to be included. Based on data availability, the type of moderator used were defined and the chosen moderators were prepared for analysis. Prepared were: prevalence of NSSI, the means of original acquired capability for suicide scale and the fearlessness about death scale – being the revised version of the acquired capability for suicide scale – as well as age, as mean and the percentage of males in a sample, coded as sex.

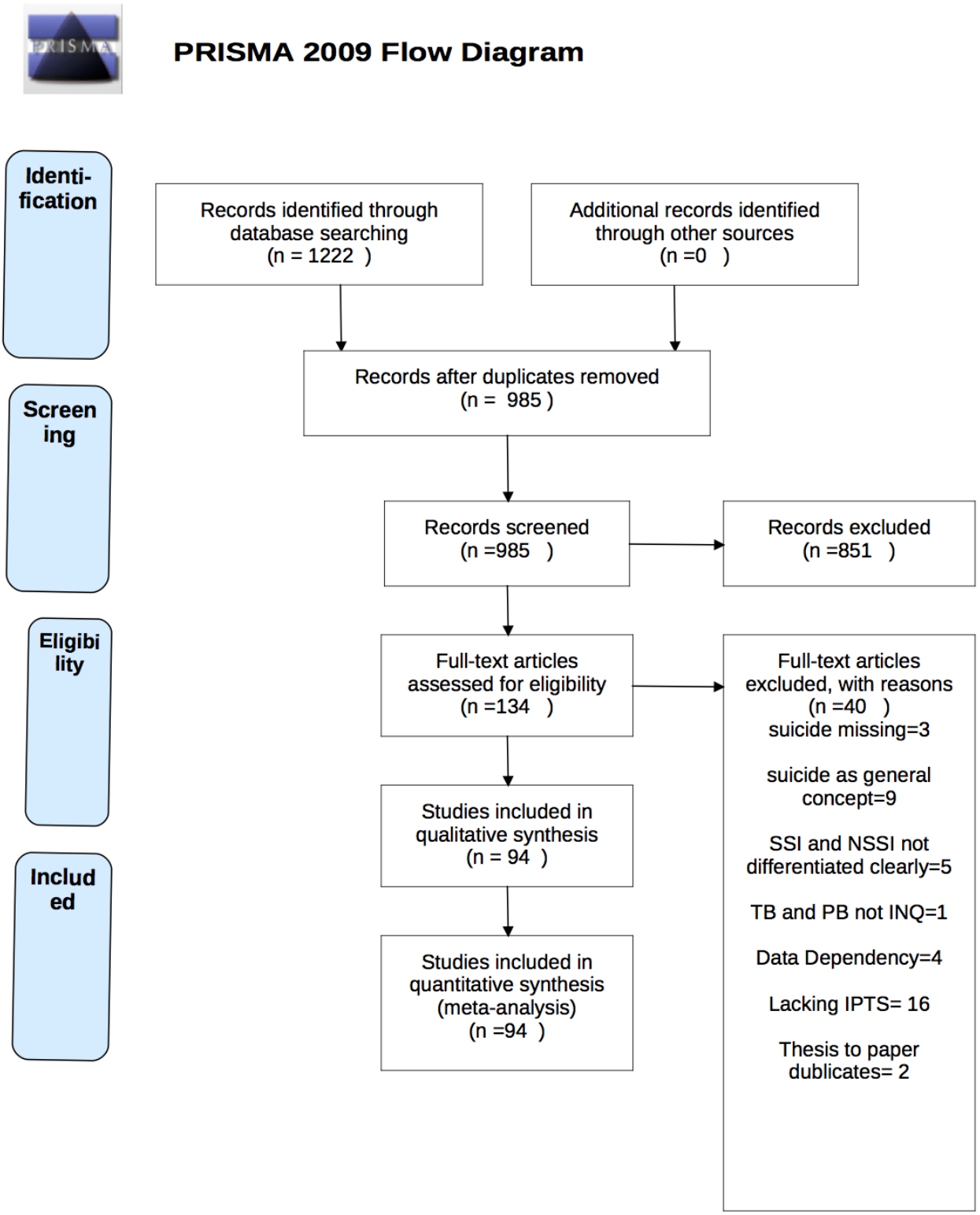
As the function NSSI is the main focus of analysis, an additional investigation of the possibility to include more than the prevalence of NSSI –as a moderator– was performed.

This was done, as during the first coding phase it became apparent that severity measurements of NSSI were split in multiple non-combinable subtypes, these being: episodes of NSSI, number of used methods, total frequency of NSSI incidences, and NSSI frequency categorized.

These non-combinable subtypes must further had to be categorized according to the prevalence type used by the study.

These non-combinable subtypes had to be categorized according to the prevalence type used by the study, as combining different types of prevalence is questionable at best and as such had not been done in any analysis. The additional investigation was done by coding all studies that reported NSSI a second time, now including the differences in measurement observed during the first study coding. Furthermore, the type of prevalence reported was re-coded. The results of the second coding were compared to the results of the first coding process. Discrepancies regarding type and percentage in prevalence of NSSI were resolved by a third (separate) coding.

Figure 2.



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For more information, visit www.prisma-statement.org.

Methods used for meta-analysis

To meta-analyse the data two methods were chosen: (a) *Two stage structural equation modelling approach (TSSEM)* and (b) *One stage structural equation modelling approach (OSMASEM)*. Both methods are *correlation based meta analytical structural equation models (MASEM)*. This type of MASEM meta-analyses multivariate data, based on the reported correlation coefficients, and is noted as being able to handle missing data in the matrix.[1]

OSMASEM in particular was chosen, due its – to date – unique ability to implement continuous moderation effects (Jak & Cheung, in press); This unique ability makes OSMASEM the best choice as moderation effects are the focus of the current analysis. As per the recommendation of the developers of OSMASEM, TSSEM is used to check the *statistical validity* of OSMASEM. Recommended as TSSEM is an established and statistically validated method, while OSMASEM is new, since the presenting paper being published was a preprint in 2019 (Jak & Cheung, in press).

Convergence & Moderators. Moderators reduce the probability of *convergence* in OSMASEM. With Jak and Cheung (Jak & Cheung, in press, p. 24) state, that in theory an unlimited amount of moderators are possible, the probability of convergence is lowered with each additional moderator. As such convergence of the data is both a restriction and a good internal evaluation for statistical reliability, as the *Full information maximum likelihood criterion (FIML)* is used for *imputation* of missing data points, within the correlation matrices.

Convergence is therein impacted by multiple factors and the interaction of those factors, among others: The number of data-points for the moderator, the total number of data points in the matrix, the degree and type of interaction implemented in the model, the number of moderators and the method used to *transform* the data. The term *transform* refers to the method used to estimate the *variance – heterogeneity of data estimation –* and is the basis for all *Standard Errors (ER).*

While a precise investigation into the impact and interaction of these factors is neither the focus of the current meta-analysis, nor it is possible with the available resources, this complex interaction has to be noted, as a investigation into the interaction of convergence and moderation is needed to estimate statistical validity – though here limited to basic practical evaluations, rating the statistical validity of the present results.

Statistical validity of any output was evaluated in multiple ways: First, by checking results of OSMASEM using TSSEM; the *within study estimations* of data can be seen as statistical valid as long as the results of OSMASEM and TSSEM are comparable. Comparability is defined as TSSEM

[1] Note: A second class of MASEM exist, which meta-analyse based on reported parameters.

and OSAMSEM returning the same direction of effect. This imprecision is needed as both operationalize moderation differently. TSSEM estimates moderation by sub-grouping correlation matrices according to the moderator and OSMASEM is using a regression approach to model moderation.

Second, the statistical validity of the *between study effect estimations*, are used to estimate general validity. Implemented by (a) observing if any *invalid between study heterogeneity* estimations emerged, such as a R^2 of one. (b) If the convergence is dependent on the used transformation. Should an individual between study heterogeneity estimation return impossible results, these between study effect estimations are invalid, as well as all values dependent on this estimation. If the convergence of the data is dependent on the transformation method, between study estimations should be interpreted with caution, as any limitation regarding convergence is a warning signal for the reliability and validity of an analysis.

Analysis

As the studies are split in subsets, according to the moderators reported - those being (a) NSSI, with k = 27 matrices, (b) the original acquired capability for suicide scale, k = 19 matrices and (c) the revised acquired capability for suicide with k = 21 matrices, and (d) and Base[2] with k = 108- the comparability of these subsets must checked.

This was done by observing effects of the common moderators sex and age. Assuming *Missing at random (MAR)* (Enders & Littlee, 2010; Graham, 2009; Yuan & Kano, 2018; Rubin, 1976), all studies should be impacted comparatively by these common moderators.

Meaning that if a subset, with a smaller k is returning completely different estimations of the moderation effect of sex or age, this is likely due to a too small *k,* to still model a moderation and not different moderation qualities.

This thereby gives a proxy estimation into the statistical validity of the moderation analysis, pending *k,* when using NSSI and the acquired capability for suicide scales, as moderators.

Based on a simulation study Jak and Cheung (2018) recommend k = 44 for a general analysis and k = 22 for subsets, when using TSSEM. In practice, most MASEMS remain below k = 30 (Sheng, 2016) and even the exemplary data sets used by Cheung – in the R-package metaSEM – often includes less then k = 30, while in the OSMASEM presenting paper Jak & Cheung used a dataset reporting k = 32 studies, with a sub-analysis deleting 3/6 of all correlations. In this sub-

[2] Note: All Study sets are subsets, as these are drawn from a larger sample of studies, of which some do not provide correlations or moderation effects needed to be included (e.g., Base here excluding 3 studies due to missing moderation effect and 2 Studies based on missing correlations.)

analysis with $k = 32$ and a missing rate of 50% Jak & Cheung still applied a moderator to show the methods robustness. It can be stated that: In practice, it is both feasible and common to accept a large number of missings and fewer than $k = 44$.

All calculations are done in R 3.5.3 (R Development Core Team, 2019), using the packages metaSEM 1.2.3 (Cheung, 2015) and OpenMx 2.14.11 (Michael et al. 2016; Pritikin, J. N., Hunter, M. D., & Boker, S. M., 2015; Hunter, 2018).

Implementation of analysis. First all study subsets were calculated without any moderation using both TSSEM and OSMASEM and checking the statistical validity of OSMASEM. Then, every applicable moderator was applied to every individual subset of studies limiting the amount of moderators to one at a time. This has been done for the study subset independent moderators age and sex as well as the study subset defining moderators: NSSI, the original acquired capability for suicide scale and the revised scale: *'fearlessness about death'*, the latter three will collectively be referred to as *'specific moderators'*.

These specific moderators were once applied on all variances of the model and once on the theorized variance between suicide ideation and suicide attempt. This was done as the theory states, that the specific moderators are only to be applied on a single variance; while in OSMASEM a moderation effect on only one variance was never tested before.

Moreover, two moderators at a time were applied. As this is also yet untested, results of this analysis are reported, but not used to answer hypotheses.

In this set-up effects of moderation can be investigated in three ways: The first way applies multiple moderation effects within one set of studies sequentially, allowing the use of Akaike information criterion (AIC). The second way uses the same moderator in different subset of studies. In this way, it can be checked, if the moderator effect is dependent of the study subset. Should this be the case, the ability of study subsets to return correct results is questionable. Third way compares the results of the specific moderators: NSSI, acquired capability for suicide scale (ACSS) and fearlessness about death (FAD), to contextualizing these moderation effects.

Inherent limitations of meta-analysing a path-model. The implemented model is a simplified version of the path-model presented by van Orden (Van Orden et al., 2010).

Comparing the simplified version (see figure 1) to the original the two main simplifications are: (a) To not included the differentiation of passive and active suicidal ideation, as few studies are differentiating them. (b) To not include hopelessness, as in van Orden (2010) hopelessness would either have to be a moderator or a mediator, in both cases increasing the percentage of missings

significantly, and thus making convergence unlikely.

Furthermore, a co-variance is modelled between thwarted belongingness and perceived burdensomeness. This covariance is not part of the original path-model by van Orden (Van Orden et al., 2010) as the original includes variables explaining both thwarted belongingness and perceived burdensomeness. The choice to include a co-variance between the two variables thwarted belongingness and perceived burden was made, as without a covariance the AIC is raised by 195.8 points – in an unmoderated model of the base study-set. Without these three simplifications, convergence would likely be impossible.

Heterogeneity. *Heterogeneity* estimation in MASEM is an unsolved issue, as a general or agreed operationalization of heterogeneity does not exist. Thus, the discussion is limited to the heterogeneity estimation as used by the current methods.

In TSSEM it is possible to depict *correlation based heterogeneity* -on stage one- using *Q* Statistics. This is limited as this is *not* representative of the heterogeneity in the applied model, which is established in stage two. Meaning that not the heterogeneity in the analysed model is depicted, but the heterogeneity of the base data is.

OSMASEM tries to estimate correlation based heterogeneity in the applied model by using the *proportion of between-studies variance (*τ^2) values. The τ^2 can only inform if results were heterogeneous, or not (Lin, Chu & Hogdes, 2017). In OSMASEM the R^2 can be applied, which is defined as $1 - (\tau^2_1/ \tau^2_0)$[3], as such it estimates the amount of explained heterogeneity, by the chosen moderator (see Jak & Cheung, in press). In practice this means that, in this analysis, only the R^2 is reported, as adding τ^2 estimations, would not raise the informative value.

To better convey the complexity of heterogeneity estimation in MASEM, the following: The most prominent version of heterogeneity modelling in MASEM is *FIMASEM (full information meta analytical structural equation modelling)*. FIMASEM, to date appears to be the only method supplying heterogeneity estimations, comparable in capability to traditional *Q* statistics. For this FIMASEM uses *bootstrapping,* the downside of the process applied by FIMASEM is that all test statistics, apart from the heterogeneity, are likely incorrect (Wilson, Polanin,& Lipsey, 2016; Cheung, 2017; Yu, Downes, Carter, & O'Boyle, 2018;Yu, Downes, Carter, & O'Boyle, 2016).

A final remark on heterogeneity investigation: All MASEM here are correlation based MASEMS, these assume that heterogeneity is based on the between the correlations and not the variances. This assumption not shared by *parameter based MASEMS*, which assume, that heterogeneity is based in the variances between the parameters, not the correlations (see Ke, 2019).

[3] Note: τ^2_1 = estimation with a moderator, τ^2_0 = estimation without a moderator

Results

Systematic review

Due to the large number of studies, the qualitative review limits itself to a short overview of the studies used (see table 1). In total $k = 94$ studies with $n = 44{,}996$, were included, mostly from the USA. The smallest study had an $n = 30$, the largest an $n = 6{,}504$, with a mean of $n = 414$. The reported distribution of sex ranged from 0 – 100% male, with a mean of 38.96% male. The reported age ranged from 13.53 to 72.29 years, the mean reported age was 26.38 years. The largest population sources were students, military and clinical sample, followed by community and online samples. Almost all studies in these had a cross-sectional design, with few longitudinal studies. Almost all studies collected data especially for their respective studies and only a handful used data from larger surveys; T0 was used, when studies were longitudinal If studies used survey data it was checked, that no other study used data from the same survey.

Remarkable is the low *n*, in the studies observed, with around 20 studies, reporting less then 100 participants. Which must result in power far below the acceptable cut-off value of power =.8 when comparing these *n*, to the simplest Monte Carlo estimations achieving acceptable power, in SEM (Muthén & Muthén, 2002) and reflecting poorly on the standard in clinically applied SEM.

Table 1: Overview of used studies

Study ID	Type	n	% Male	age	Pop-Source	country	Analysis allocation
Ai(2017)	1	2758	46	13.53	School	PRC	1
Andover(2010)	1	117	38.5	39.45	Inpatients	USA	1,2,6h
Anestis(2011)	1	492	41.3	26.99	Outpatient	USA	1
Anestis(2014a)	1	93	55	36.25	Treatment seeking	USA	1,2.6l
Anestis(2014b)-I	1	1317	20.8	21.12	Students	USA	1,2
Anestis(2014b)-II	1	706	17.2	21.16	Students	USA	1,2
Anestis(2015)	1	1317	21.2	21.11	Students	USA	1,2,4
Anestis(2017)	1	100	24	23.63	Community	USA	1,4
Assavedo(2016)	1	999	19.8	21.18	Students	USA	1,2,6l
Baertschi(2017)	1	167	38.3	33.6	Inpatients	CHE	1
Barzila(2015)	1	1196	79.01	15.91	School	ISR	1
Bear(2018)	1	134	71.16	30.14	Military (crisis center)	USA	1,3
Blankenship(2018)	0	515	43.7	36.02	MTurk Amazon	USA	1,5
Branley-Bell(2019)	1	299	34.8	27.35	Community	USA	1
Brown(2019)	1	103	54.4	35	Inpatients	USA	1,2
Burke(2016)	1	447	22.6	21.11	Students	USA	1,3
Burke(2018)	1	520	24	20.61	Students	USA	1
Campos(2016)	1	200	51	36.7	Community	PRT	1
Chang(2017)	1	195	42	21.02	Students	HUN	1
Chu(2016a)	1	1566	92.6	29.88	Military	USA	1,2,4
Chu(2016b)	1	49	22.4	18.84	Students	USA	1
Chu(2017a)-I	1	508	33	18.94	Students	USA	1

Table 1 (continued)

Chu(2017a)-II	1	310	19	19.09	Students	USA	1
Chu(2017b)-I	1	858	90.7	37.3	Fire-fighter	USA	1
Chu(2017b)-II	1	352	38.6	27	outpatient	USA	1
Chu(2017b)-III	1	469	28.1	19.4	Students	USA	1
Chu(2018a)	1	973	78.8	29.94	Military	USA	1,2,3,5
Chu(2018b)	1	105	34.6	19.3	Students	USA	1
Damirchi(2019)	1	120	25	33.69	Hospital nurses	IRN	1
Davidson(2013)	1	60	38.3	26.15	Outpatient	USA	1,3
DeShong(2015)	1	348	34.2	19.45	Students	USA	1
Dhingra(2019)	1	665	28.5	24.2	Students	GBR	1,5
Drapeau(2016)-I	0	266	71.8	24.07	Epilepsy support groups	USA	1
Drapeau(2016)-II	0	300	45	24.78	MTurk Amazon	USA	1
Eaddy(2017)	1	151	17.9	15.1	Inpatients	USA	1,4
Floyd(2016)	0	80	24.7	19.11	Students	USA	1
Forrest(2019)-I	1	447	45.9	35.4	MTurk Amazon	USA	1,4
Forrest(2019)-II	1	403	44.9	38.1	MTurk Amazon	USA	1,4
Fox(2016)	1	183	13.2	25.16	Internet	USA	1,2,6h
Gai(2017)	0	813	90.4	40.27	Fire-fighters	USA	1,2,4,5
Gaskin-Wasson(2018)	1	66	0	36.18	Health care provider	USA	1
Gauthier(2018)	1	92	39	37.36	Trauma hospital	USA	1,2
George(2016)	1	611	26.3	20.99	Students	AUS	1,5,6h
Gordon(2010)	1	106	17	21	Mixed	USA	1,2,6l
Granato (2017)	0	155	41.1	56.69	Mitchell Cancer Institute	USA	1
Gunn(2018)	1	6504	48.4	16.04	High School	USA	1
Hagan(2017)	1	50	34	18.7	Students	USA	1,5
Hansen(2013)-I	0	93	26	70.9	Community	USA	1,3
Hansen(2013)-II	0	187	61	20	Students	USA	1,3
Hawkins(2014)	1	215	34.6	26.47	Outpatient	USA	1,4,5
Hill(2013)	1	449	26.9	20.4	Students	USA	1
Hollingsworth(2012)	0	371	21.3	19.18	Students	USA	1
Hom(2018)	1	624	77.9	25.24	Military	USA	1
Horton(2016)	1	147	23.8	14.72	Inpatients	USA	1,4
Hunt(2018)	0	117	21.2	14.89	Therapy evaluation	USA	1,2
Jahn(2011)	1	70	44	72.79	Medical Clinic	USA	1
Jahn(2015)	1	110	41.82	36.45	Inpatients	USA	1
Kacmarski(2016)	0	435	29.4	18.73	Students	USA	1,3
Kang(2018)	1	1074	54.2	13.87	High School	PRC	1,2,5,6h
Khazem(2015)	0	184	23.1	22.83	Students	USA	1,4
King(2016)	0	56	17.4	14.93	Suicide prevention	USA	1,4,5
Kleinman(2014)	1	245	20.8	20.4	Students	USA	1
Klonsky(2015)	1	910	53	31	MTurk Amazon	USA	1,3,5
Kwan(2017)-I (F)	1	315	0	19.3	Students	USA	1
Kwan(2017)- II (F)	1	1000	0	19.2	Students	USA	1
Kwan(2017)I (M)	1	259	100	19.3	Students	USA	1
Kwan(2017)-II (M)	1	791	100	19.2	Students	USA	1
Kyron (2019)	1	299	34.8	27.53	Web based	AUS	1
Lindsey(2013)	1	185	48.1	38.12	Military, Inpatients	USA	1,3,5
Lindsey(2015)	1	122	92.26	54.4	Military,	USA	1,5
Mbroh(2018)	1	289	20.42	14.88	Inpatients	USA	1,2,4,5,6h
Merchant(2010)-I(F)	0	26	0	15.5	emergency department	USA	1
Merchant(2010)-II(M)	0	44	100	15.3	emergency department	USA	1
Miller(2015)	1	143	36	15.38	Outpatient	USA	1
Miller(2016)	1	143	36	15.38	Outpatient	USA	1,2
Misra(2013)	0	762	30	20	Students	USA	1,2,3,6l
Mitchell(2018)	1	142	55.6	37.77	inpatients	USA	1
Monahan(2012)	0	82	34.1	19.51	Students	USA	1,2
Monteith(2013)	1	185	48.1	38.12	Veterans, Inpatients	USA	1,3,5

Table 1 (continued)

Monteith(2015)	1	122	92.6	54.4	Veterans	USA	1,5
Monteith(2017)	1	97	0	42.14	Veterans (trauma inpatient)	USA	1,4,5
Naidoo(2016)	0	239	32	36.4	outpatient	ZAF	1,4
Olson(2016)-I (F)	0	38	0	17.05	Middle School	USA	1
Olson(2016)-II (M)	0	49	100	17.22	Middle School	USA	1
Opperman(2015)	1	129	33.3	13.67	Emergency department	USA	1
Patterson (2015) I–University	0	417	12.1	18.39	Students	CAN	1,2,3,5,6l
Patterson (2015) II–Community	0	533	43	35.21	Community	USA	1,2,3,5,6l
Podlogar(2016)	1	307	40.7	14.1	School	SVN	1,5
Puzia(2014)	1	189	15.8	22.02	Students	USA	1
Rasmussen(2011)	1	452	34.4	19.87	Students	USA	1,3
Ren(2018)	1	930	46.5	16.88	High School	PRC	1,4
Roeder(2018)-I College	1	142	22	19.6	Students	USA	1
Roeder(2018)-II High School	1	56	38	16.2	High School	USA	1
Rogers(2016)	1	169	37.3	26.05	Outpatient	USA	1,4,5
Rogers(2018)	1	300	19	19.08	Students	USA	1,3,5
Roley-Roberts(2017)	1	121	22	18.69	Students	USA	1,2,6h
Roush(2019)	1	118	53.4	36.17	Inpatients	USA	1,2
Schönfelder(2019)	1	84	30.9	37.6	Inpatients	GER	1
Smith(2015)	1	30	40	30.83	Community	USA	1,3
Smith(2018)	1	91	11.2	21.72	College & Community	USA	1,2,3
Soberay(2018)	0	56	37.3	50.5	Military	USA	1,2,4,5
Stewart(2017)	1	340	27.86	15.59	Acute psychiatric treatment	USA	1,2,6h
Taylor(2016)	1	90	38.9	37.2	Inpatients	USA	1
Wolford-Clevenger(2017)	1	396	78.78	34.55	Domestic violence offenders	USA	1,3,5
Wolford-Clevenger(2019)	1	206	27	19.05	Students	USA	1,3
Yang(2018)	1	1097	43.8	19.77	Students	PRC	1,4
Zullo(2017)	1	151	17.9	15.05	Inpatient	USA	1,4
Zuromski(2014)-I Control	0	94	18.1	19.6	Students	USA	1,4
Zuromski(2014)-II Diatry Restricted	0	99	14.1	19.8	Students	USA	1,4

%Peer Re-viewed	mean of *n*	% male	Mean of age	% Students	% USA
76	414	38.96	26.38	25	86

Note: Type is either 0= thesis, or 1= peer reviewed publication; Analysis allocation 1= base subgroup, 2= NSSI subgroup, 3= ACCS subgroup, 4= FAD subgroup, 5= No missings in Matrix; 6h =NSSI severity high, 6l= NSSI-severity low; roman numerals signify that a study provides two (or more) independent data sets and refers to said independent sample; F= only Female; M= only Male.

Data availability

Data availability is reported in table 2, with a total range of n = 3,397 to 25,888, per cell and $k\,m$= 5 to k = 83. The lowest rate of missing in the modelled data was 25%, the highest 56% (see table 3), meaning that in some study subsets more missing had been included, than in the demonstration

analysis of Jak and Cheung, which had a missing of 50%. The percentage of missings and the number of *k* correlated with $r = .32$.

Table 2
Data availability reported according to study subsets.

Base (*k=108)*	Sa	SI	TB	PB	NSSI (*k* =27)	Sa	SI	TB	PB
Sa		36	26	27	Sa		11	8	8
SI	22216		75	77	SI	4916		12	11
TB	11493	24653		82	TB	5472	4650		17
PB	12175	22660	25888		PB	5472	4650	8078	
ACSS (*k*= 19)	Sa	SI	TB	PB	FAD (*k* =21)	Sa	SI	TB	PB
Sa		9	8	8	Sa		10	9	8
SI	3929		15	15	SI	4291		18	17
TB	3899	5779		18	TB	4578	6273		18
PB	3899	5779	6766		PB	3012	4707	6024	
NSSI as SA (*k*=110)	NSSI	SI	TB	PB	NSSI serv. (*k*=13)	SA	SI	TB	PB
NSSI		18	16	16	SA		9	5	5
SI	8721		75	78	SI	4884		5	5
TB	9256	26237		83	TB	3397	3397		7
PB	10452	26098	28323		PB	3397	3397	3397	

Note: lower section= n; Upper section = k.
NSSI = Non-suicidal self-injury; ACSS = Acquired capability for suicide scale (original); FAD = fearlessness about death (revised ACSS-Scale); NSSI as SA = Model with NSSI in place of suicide attempts; NSSI severity split = Study sets split according to reported NSSI severity.

Table 3
% of Missing in data, according to study subset.

Subset of studies	In Matrix	In modelled variances
Base	50	37
NSSI	59	53
ACSS	34	25
FAD	51	25
NSSI as SA	43	56
NSSI severity split	54	50

Note: NSSI = Non-suicidal self-injury; ACSS = Acquired capability for suicide scale (original); FAD = fearlessness about death (revised ACSS-Scale); NSSI as SA = Model with NSSI in place of Suicide attempts; NSSI severity split = Study sets split according to reported NSSI severity.

Data availability of moderators. While the common moderators age, sex, as well as both acquired capability for suicide scales, provided obvious choices for the moderator, being reported mean, for age, and both scales, and percentage of males, for sex, for NSSI, this was not the case.

In NSSI a number of non-combinable subtypes of measurement were observed, as well as different

types of prevalence. An additional specific analysis was implemented,, which returned the data depicted in table 4.

Table 4
Data availability of NSSI (as *k)*, split according to prevalence and measurement type

	Type of Prevalence				
Type of Measurement	Lifetime	Year	Month	Week	Total
Episodes	9	2	2	1	14
Methods	5	2	0	0	7
Total frequency	2	1	0	0	3
Categorized frequency	5	1	0	0	6
Other	1	0	0	0	1
Total:	22	6	2	1	31

Note: Other denotes group only used once.

Based on the observations made in table 4, the following adaptations were implemented: (a) The prevalence year and month were excluded, as not enough data was reported. (b) Using means for NSSI (severity) is not possible, as no single type of measurement reported sufficient data. (c) Studies reporting NSSI were divided into subsets, either reporting more severe or less severe NSSI. These subsets were used for an additional TSSEM based moderation analysis.

Evaluation of NSSI severity in a study was done on the basis of the type of prevalence and the reported severity. Due to the quantitative non-combinability of the NSSI severity measurements distinctions of the relative severity between two studies, using different types of measurement, isto a large degree a matter of personal intuition.

The inclusion of NSSI severity additionally provides a comparative measurement to NSSI-prevalence. Should both severity and prevalence return comparable moderation effects, it may be stated that both capture a common element, likely the effect of NSSI, increasing confidence in the estimation. Study allocation is reported in table 1, allowing for re-evaluation of group allocation.

Controlling the MAR assumption in all study subsets. If the study level missing at random assumption is true, no differences in population parameters between study subsets, should be observed (see table 5). To check this reported *n*, sex, age and population sources were compared, between the different study allocations. Between these MAR seems to hold, as long as a subset remained above $k = 20$. Study subsets below tended to deviate. The largest deviant was observed in the original the acquired capability for suicide scale study subset, regarding population source, reporting 47.7% of students. No systematic differences were observed.

Table 5
Summary of population parameters, according to study subset.

Study set	% Published	n	% Male	Mean age	% Students	% USA
FAD	66	410	33.48	25.88	24	85.7
ACSS	72	357.68	40.62	28.57	47.70	95
NSSI	73	481.84	36.95	25.91	31	93
NSSI-High	100	390.71	28.93	21.23	29	71
NSSI- low	50	485	29.48	25.33	29	83

Note: See Table 3 for allocation of individual studies to study sets; NSSI = Non-suicidal self-injury; ACSS = Acquired capability for suicide scale (original); FAD = Fearlessness about death (revised ACSS-Scale); NSSI-High= Study set with higher reported cases of NSSI; NSSI-Low = Study set with lower reported cases of NSSI.

Effects of using study subsets, in OSMASEM and TSSEM

Comparing TSSEM and OSMASEM estimation in unmoderated models. Without any applied moderation, no differences in variance estimation was observed – in any study subset – between TSSEM and OSMASEM (see: figure 3). Thus, OSMASEM fulfilled the basic requirement for statistic validity.

Figure 3. (Co)-Variance estimation, for OSMASEM and TSSEM.

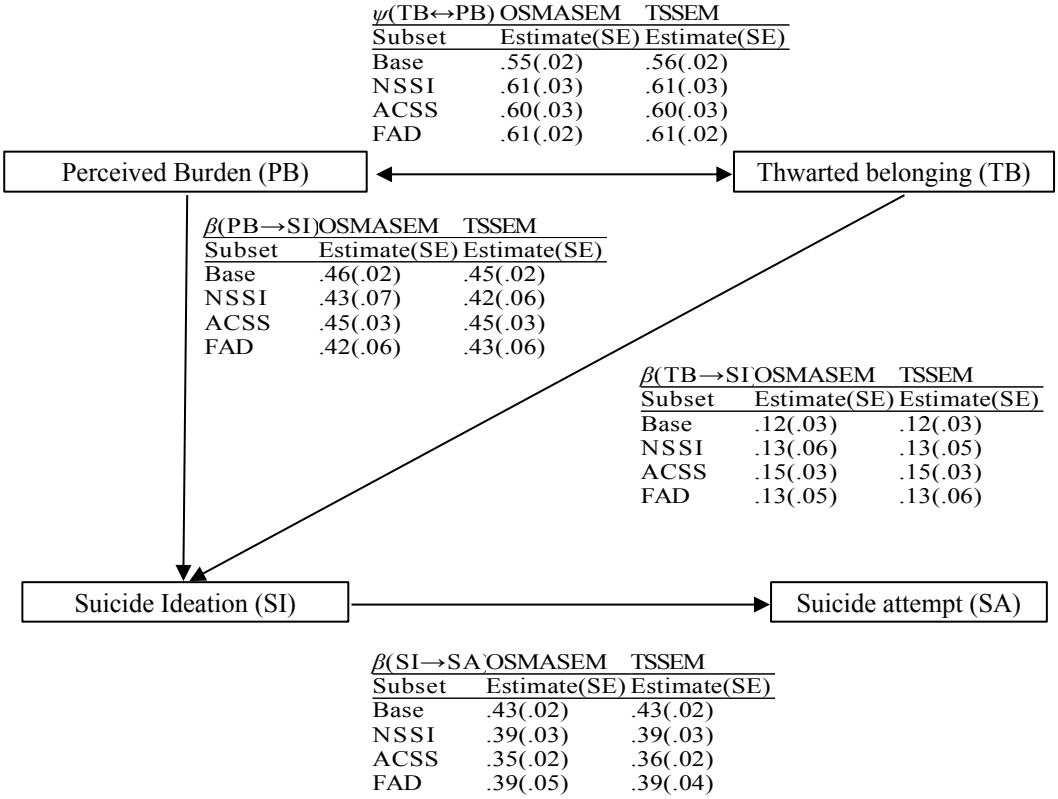

Figure 3. Controlling if (co)-variance estimations differ, due to used method (TSSEM or OSMASEM); β = Variance; ψ = Covariance; Base = All studies reporting data for model; NSSI = Non suicidal self injury study subset; ACSS = Acquired capability for suicide study subset; FAD = Fearlessness about death study subset.

Impact of study subsetting in moderation analysis. When comparing moderation effect estimations between study subsets, OSMASEM mostly returned results with the same effect directions and comparable estimations (see figure 4).

Figure 4. Moderation-effect of sex and age, in all study subsets, for OSMASEM

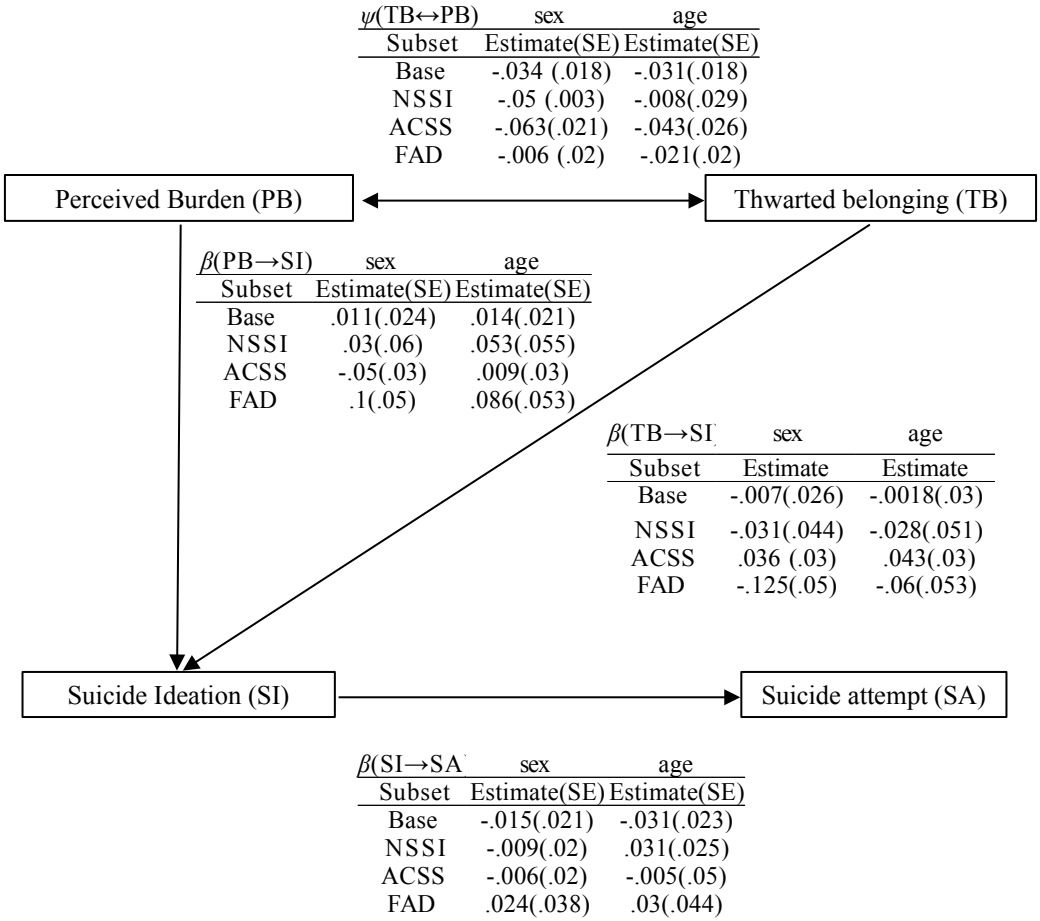

Figure 4. Checking how moderation effect estimation is influenced by sub setting of studies; β = Variance*;* ψ = Covariance; Base = Base = All studies reporting data for model; NSSI = Non suicidal self injury study subset; ACSS = Acquired capability for suicide study subset; FAD = Fearlessness about death study subset.

Given the observed differences, moderation analysis is possible, using OSMASEM, precluding the original acquired capability for suicide scale study subset, which did not return comparable results; It is likely that the precluded subset had not enough data, to include a moderator. Results from this subset must be treated with caution, as statistical validity is questionable.

TSSEM estimations of moderation effects returned overall mixed results. These mixed results are due to TSSEM operationalizing moderation by splitting studies, according to the moderator, in multiple subsets. This process is far less efficient and precise than OSMASEM and in in turn not surprising that this leads to incongruent effect estimations, given the low *k* (see figure 5).

Figure 5. Moderation-effect of sex and age, in all study subsets, for TSSEM

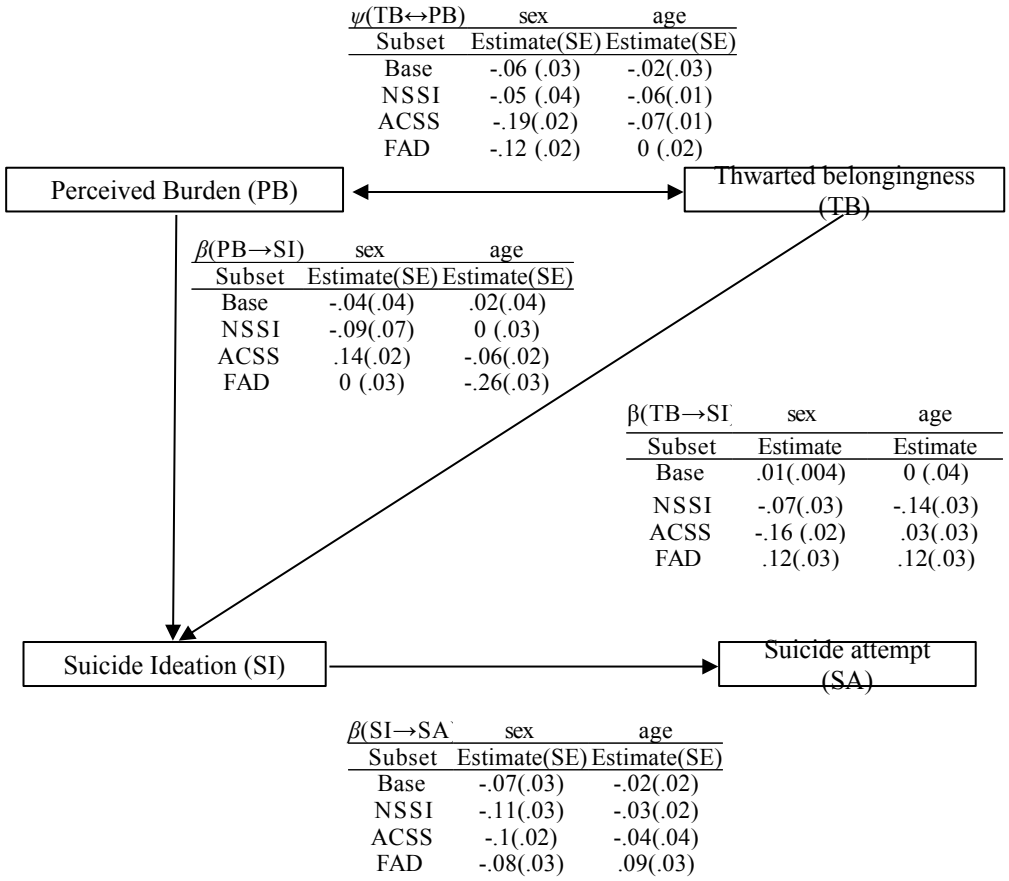

Figure 5. Checking if estimation of TSSEM is depended on study subsetting. Difference is operationalized by subtracting the estimation of both groups (higher – lower moderator expression), expressed as difference in correlation; β = Variance; ψ = Covariance; Base = All studies reporting data for model; NSSI = Non suicidal self injury study subset; ACSS = Acquired capability for suicide study subset; FAD = Fearlessness about death study subset.

Based on these results and the fact that in TSSEM the decision of where a originally continuous moderator is used to split the studies in subsets, a decision that can easily be misused (Cheung, 2015, pp.233). Therefor TSSEM is not used to analysing the specific moderators, as these are seen as conceptually continuous and have few data entries. As such only results from OSMASEM are presented.

Model specification. The statistical validity of the estimated model for OSMASEM was checked using two indicators: (a) *If invalid explained variance estimations* were observed within the results and (b) If *convergence was dependent* on the transformation.

Results, when using study subsets, partly returned warnings of misfitting model specification; as such reenforcing the point, that hypotheses should only be answered, based on analysis using one moderator at a time (see table 6). Doubt to the ability of the the original acquired capability for suicide scale study subset, to return statistically valid results is re-enforced.

Table 6
Overview of specification quality (OSMASEM), in all moderated models and study set.

	Impossible explained variance reported					Depended convergence				
Subset	sex	age	Specific1	Specific2	Sex&age	sex	age	Specific1	Specific2	Sex & age
Unaltered model										
Base										
NSSI										
ACSS										
FAD										
Model, with nonsuicidal self-injury in place of Suicide attempt										
Base										
ACSS										
FAD										

Note: Green = No warning; Red = At least one warning; Grey = Not applicable/modelled;
Specific 1 = Specific moderator on all variances; Specific 2 = Specific moderator only on variance between suicide ideation and suicide attempts/NSSI; Base = All studies reporting data for model; NSSI = Non- suicidal self-injury study subset; ACSS = Acquired capability for suicide study subset; FAD = Fearlessness about death study subset.

Model specification in TSSEM. Is checked by the in OpenMX implemented indicator for model specification, should the indicator return results marked as misspecified, results are not included.

Figure 6. Heterogeneity (τ^2) estimation

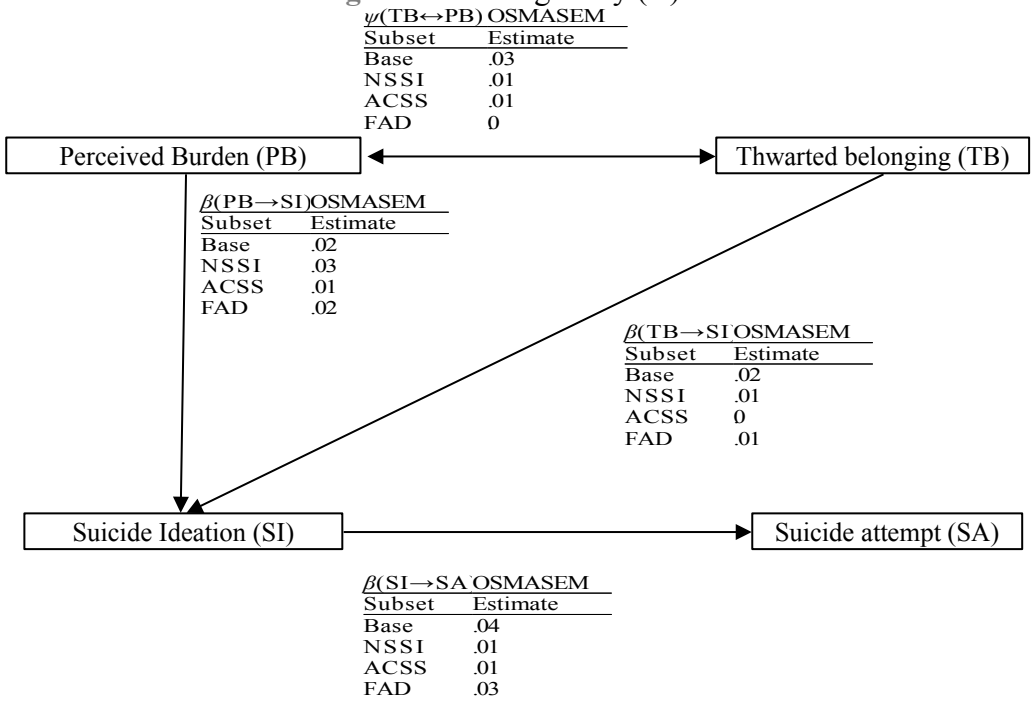

Figure 6. All τ estimate, $\tau^2 = 0$, meaning (co-)variance is homogeneous, $\tau^2 > 0$, meaning (co-)variance is heterogeneous; β = Variance*;* ψ = Covariance; Base = All studies reporting data for model;
NSSI = Non suicidal self injury Study subset;ACSS = Acquired capability for suicide study subset;
FAD = Fearlessness about death study subset.

Heterogeneity. As already stated, heterogeneity will not be investigated, separately form the R^2, in

the main analysis. An overview, of all τ^2, in an unmoderated model is given in figure 6. Results indicate the existence of heterogeneity, within the data.

Hypotheses testing

Hypothesis 1. Moderators age and sex, both, if measured together, as well as independent parameters have a significant effect on the model fit.

Using OSMASEM the impact of age and sex, was insignificant on the model (see table 7). This excludes results from the study subset 'acquired capability for suicide scale', as the subset included invalid explained variance estimations (see table 6). Using a random effects TSSEM (Base study set) moderation also remained insignificant, for sex *(p* = .052) and age (*p* = .051). Hypothesis 1 is rejected.

Table 7
Model impact of moderators: sex and age, on path-model, using OSMASEM

	Sex only		Age only		Sex and age	
Subset	*p*	AIC-Diff	*p*	AIC-Diff	*p*	AIC- Diff
Base	.3	3	.26	3.2	.42	8
NSSI	.31	3	.53	5	.15	5
ACSS	.044*	-2	.15	1	.029*	-1
FAD	.16	1.2	.29	2	.21	5

Note: AIC-Diff = Difference in Aikes Infromation Critirion; * significant result; Base = All studies reporting data for model; NSSI = Nonsuicidal self-injury study subset; ACSS = Acquired capability for suicide study subset; FAD = Fearlessness about death study subset.

Hypothesis 2. The moderating effect of the acquired capability for suicide differs between the original scale (ACSS) and the revised version of the scale (FAD).

The hypothesis was tested in two steps: First a moderation analysis was implemented, in which the moderators were applied on all variances, of the model. Second, the moderation effect is only applied on the theorized variance, between suicide ideation and suicide attempt. (see figure 6) This was done, as applying a moderator on a single variance is yet unprecedented.

Fearlessness about death was the superior moderator. With 30% against 20.7% explained variance, if applied on all variances and with 36% against 21% explained variance, when applied only on the variance between suicide ideation and suicide attempt.

As the study subset for the acquired capability for suicide scale returned warnings regarding a invalid explained variance, *model impact estimations* cannot be used, as these are depended on the explained variance estimations. Furthermore, the negative moderation effect of the scale generally raises doubt about the ability of the study subset to return valid results, as the direction is

per design supposed to be positive.

The model impact of FAD remained with $p = .052$ insignificant, which makes a insignificant model impact of original acquired capability for suicide scale likely, given the lower explained variances. It is concluded that the revised scale: Fearlessness about death showed superior moderator qualities, between suicide attempt and suicide ideation, than the original acquired capability for suicide scale.

Hypothesis 3. The moderating effect of NSSI is significantly higher on the variance between suicide ideation and suicide attempt than the moderating effect of the acquired capability for suicide scales.

NSSI moderation quality was comparable to that of the 'original acquired capability for suicide scale', but clearly an inferior moderator to the fearlessness about death scale (see figure 6). Remarkably, the moderation direction of NSSI on the relation of suicide ideation and suicide attempts was negative. This implyies that the higher the NSSI prevalence, the lower the relationship between suicide ideation and suicide attempt. When using NSSI-severity in a fixed effect TSSEM, the same negative direction is observed (table 8). This congruence lowers the likelihood of this observation being the result of misspecification or erroneous imputation; supported by the absence of any warnings, regarding model misspecification.

Table 8
TSSEM variance estimations of study sets, split according to NSSI severity

(Co)-Variance	Less severe NSSI	More severe NSSI
Suicide attempt→suicide ideation	.50 (.03)	.34(.01)
Thwarted belonging→suicide ideation	.11(.05)	.14(.03)
Perceived Burden→suicide ideation	.51(.05)	.30(.03)
Perceived burden →thwarted belonging	.70(.01)	.63(.02)

Note: TSSEM applying a fixed effect model, with $k = 7$, for the more severe group and with $k = 6$, for the less severe group.
RMSEA, for less severe was 0.02 and for more severe 0.05 and considered fine, see Browne (1992) as recommended by Cheung (2015).

Introducing sex and age as additional moderators. When using sex or age additionally to one of the study subset defining moderators, only the combination of sex and NSSI resulted in a significant model impact, with $p = .020$. As the estimation is only converging using one type of transformation, statistical validity remains questionable.

All other statistical significant model impacts were most likely the result of invalid between study heterogeneity explanations and should not be seen as statistically valid (see table 9).
It is concluded that the the fearlessness about death scale is a superior moderator. The hypothesis is rejected.

Table 9
Study subset defining moderator and age or sex (OSMASEM based)

Study Subset.	Model impact		Specification quality	
	p	AIC-Diff	RS Impossible explained variance	Depended convergence
Section I: Age as additional Moderator				
NSSI	.45	8	.	
NSSI [β(SI→SA)Only]	.2	1	.	
ACSS	.05*	1	.	
ACSS [β(SI→SA)Only]	.09	-1	.	
FAD	.29	6	.	
FAD [β(SI→SA)Only]	.14	-.003	.	
Section II: Sex as additional Moderator				
NSSI	.02*	-2	.	
NSSI [β(SI→SA)Only]	.018*	-4	.	
ACSS	.0014*	-3	0	
ACSS [β(SI→SA)Only]	.090	-1.3	-	
FAD	.11	-3	0	
FAD [β(SI→SA)Only]	.14	-.02	0	

Note: AIC-Diff = Difference in Aikes Infromation Critirion; * significant result; Green = No warning; Red = At least one warning; NSSI = Nonsuicidal self-injury; ACSS = Acquired capability for suicide scale; FAD = Fearlessness about death scale; β(SI → SA) = variance of suicide ideation to suicide attempts.

Hypothesis 4. The moderation effect of the acquired capability for suicide scale differs depending on its application on the variance between suicide ideation and attempt, or suicide ideation and non-suicidal self-injury.

Comparing the unmoderated base models, no significant difference between the variances of suicide ideation to suicide attempt and suicide ideation to nonsuicidal self-injury can be observed.
While both the the original scale for acquired capability for suicide and the revised fearlessness about death scale had comparable moderation effects, when using NSSI or suicide attempts as the depended, these had flipped operator signs, pending the dependent variable.

On the one hand, it has to be noted that the estimations using NSSI as a dependent variable had very few data entries, $k = 4$ and $k = 5$ for the original and revised scale respectively, which limits statistical reliability. While on the other hand, no warnings regarding converging or mis-specification were observed.

Thus it is stated that, given the low amount of data points it would be premature to conclude anything substantial; limiting the conclusion, to a call for further research. Furthermore, only the first part of the hypothesis can be answered and as no difference between the two variances can be observed, the hypothesis is rejected.

Table 10
Variance of suicide ideation to suicide attempts, compared to variance of suicide ideation to NSSI, unmoderated and moderation effect of the acquired capability for suicide scales.

	Estimation of variance: suicide ideation → suicide attempts		Estimation of variance: suicide ideation → NSSI	
Subset	Unmoderated estimation (SE)	Moderation effect (SE)	Unmoderated estimation (SE)	Moderation effect (SE)
Base	.43 (.02)		.40(.04)	
ACSS	.35 (.02)	-.054(.027)	.63 (.07)	-0.14(0.04)
FAD	.39 (.05)	.076(0.04)	.30 (.06)	-0.089(.04)
ACSS [β(SI→SA/NSSI)Only]	.35 (.02)	-.056(.03)	.63 (.07)	0.0021(.039)
FAD [β(SI→SA/NSSI)Only]	.39 (.05)	.085(.04)	.30 (.06)	-0.084(.04)

Note: Base =All studies applicable, ACSS = Studies of subset acquired capability for suicide scale (original scale); FAD = Studies of subset fearlessness about death scale (revised scale); β(SI → SA) = variance of suicide ideation to suicide attempts; β(SI → NSSI) = variance of suicide ideation to NSSI.

Hypothesis 5. The exclusion of either thwarted belongingness or perceived burdensomeness, leads to diminished predictive capabilities for suicide ideation and reduced model fit estimations of the IPTS. Diminishing effects are moderated by sex and age.

To test the hypothesis two additional models were established: One model not including perceived burdensomeness and one model not including thwarted belongingness.

When comparing these models (see table 11), it can be observed that excluding perceived burdensomeness lowers the modelled variances to suicide ideation, but increases the RMSEA; contrary the exclusion of thwarted belongingness lowers the REMSEA but the impact on the modelled variance to suicide ideation is low.

No significant effects of moderators sex or age were observed in these estimations (see table 12).

It is concluded that neither perceived burdensomeness nor thwarted belongingness should be

excluded from the model, as the exclusion of the one leads to less predictive capabilities and the exclusion of the other to reduced model fit estimations, validating the hypothesis; barring the effect of the proposed moderators.

Table 11
Impact of excluding thwarted belongingness (TB) or perceived burdensomeness (PB) on modelled variance of suicide ideation (SI) and the RMSEA

	Variance: TB→SI	Variance: PB→SI	RMSEA
Used Model	Estimate(SE)	Estimate (SE)	Estimate (95% CI)
Standard model	.12 (.03)	.45 (.02)	.0066(0;.0130)
Excluding TB		.52(.015)	.0098 (.0031;.0189)
Excluding PB	.38(.017)		0 (0;.009)
Loss due to exclusion	.19	.05	

Note: RMSEA, is considered fine.

Table 12
Impact of moderation impact of sex and age in models pending inclusion of thwarted belongingness (TB) or perceived burdensomeness (PB).

	Moderation effect (sex)			Moderation effect (age)		
	TB→SI	PB→SI	AIC-Diff.	TB→SI	PB → SI	AIC Diff.
Used Model	Estimate(SE)	Estimate(SE)	Estimate	Estimate(SE)	Estimate(SE)	Estimate
Standard model	-.007(.026)	.011(.024)	3	-.0018(.03)	.014(.021)	3.2
ExcludingTB		.001(.02)	4		.007(0.01)	3
ExcludingPB	-.014 (.01)		3	-.007(.02)		1.2
Difference	.007	.01		.0011	.007	

Note: As the difference of no moderation effect is larger than any SE, no significant difference in moderation effects, due to exclusions of TB or PB is not observed; AIC-Diff = Difference in Aikes Information Critirion.

Publication bias

No procedures exist for publication bias investigation in MASEM (Cheung, 2015, p.8).
This is akin to the uncertainty regarding the source of heterogeneity and ca be stated as: What is to be meta-analysed in MASEM: parameters or correlations?

As such in any correlation based MASEM, like OSMASEM or TSSEM, even if no difference in model estimation can be observed, as was the case for the analysis here (see table 13). However, it does not mean that no publication bias is present.

The possibility that publication bias is *per se* not observable, when using correlation based MASEM cannot be excluded. It in fact seems likely, seen that not the parameters themselves are meta-analysed, but the correlation, on which parameters are based. This proposition implies that publication bias is not be based on the number of significant correlations within the reported matrix, but the amount of significant parameters, in the included and depicted model. As such a conclusive statement is not feasible, to the presence of publication bias.

What can be said is that no publication bias can be observed, regarding a significant difference of reported correlations (p =.06). Further a notable – if non-significant difference – was observed in the reported RMSEA, thesis: .043 CI 95% (0; 0.0117) vs. peer reviewed was .0144 CI 95% (0;0.0326).

In general the author assumes that publication bias, if it can be found, is more likely to be found, within the parameters, themselves and not within the correlation matrices, as a researcher is less focussed, when reading a paper on SEM on the correlation matrix, but the depicted model. This idea is further supported by the fact that a SEM can easily be 'optimized', to include the maximum amount of significant parameters, e.g. by introducing a new co-variance, or a mediator.

Table 13
TSSEM of unmoderated study sets, split according to publication status

(Co)-Variance	Peer reviewed	Thesis
Suicide attempt→suicide ideation	.45 (.03)	.43 (.02)
Thwarted belonging→suicide ideation	.08 (.06)	.14 (.03)
Perceived burden→suicide ideation	.52 (.04)	.43 (.03)
Perceived burden →thwarted belonging	.55 (.05)	.57 (.02)

Note: TSSEM applying a random effects model;
Model difference was insignificant with p = 0.06; RMSEA, for Thesis was .0043CI95%(0: 0.0117) and for peer reviewed was .0144 CI 95% (0;0.0326).

Discussion

Summary of evidence: Subject matter

Interpersonal theory of suicide. In the implemented version good model fit indicators and medium to strong variance estimations were observed – except thwarted belongingness, supporting general applicability of the model. The quality of the IPTS further showed itself in the respective moderation effects, with the population parameters sex and age not significantly impacting the model, while the revised scale for acquired capability to commit suicide,had with an R^2 = 36 excellent moderator qualities, which were significantly stronger then those of NSSI (R^2=17). It was not expected, that, the moderation effects of age and sex, did not significantly impacting the model, a s studies exist, which state an influence of sex on thwarted belongingness and perceived burdensomeness (Chu, Stanley, Hom, Lim, & Joiner, 2016; Donker, Batterham, Van Orden, & Christensen, 2014), but can be seen as a positive attribute of the model.

In general, the quality of the IPTS is even the weakest observed variance, the variance between thwarted belongingness and suicide ideation seemed to have its function, as it lowered the RMSEA of the total model.

NSSI. NSSI was surprising, since it showed itself rather stable – in two different measurements as well in two different methods – in having a negative moderating effect on the variance of suicide ideation to suicide attempts. This can potentially be explained by its function(s) and the fact that the outcome variable was suicide attempts and not completed suicide.

Before discussing this possibility, it may be important to clarify, what has been measured discussed here and what can and cannot be drawn from the analysis. The analysis has been based on individuals that report standardized scores on suicidal ideation and suicide attempts. How these scores correlate is the basis and focus of analysis, how the correlation is then impacted by NSSI is the current question. No statement can be made, if NSSI afflicted individuals are more often thinking about killing themselves or more often attempt to kill themselves, compared to individuals not engaging in NSSI. What *can* be said is how NSSI is affecting the relation. The result implies that individuals with suicidal ideation, engaging in NSSI, are less likely to attempt suicide, than individuals with suicidal ideation, not engaging in NSSI.

The function of NSSI. A potential explanation of this surprising result is found in the functional relatedness of NSSI and suicide attempts.

The first and most direct functional link of NSSI to suicide attempts is its function to not attempt suicide (Guérin-Marion, Martin, Deneault, Lafontaine, & Bureau, 2018; Klonsky, 2007). This function directly lowers the rate of suicide attempts in individuals enacting NSSI.

The second link – also one of the most common functions in NSSI (Klonsky, 2007) – is the function to evade aversive emotional states, observable in suicide attempts (T. E. Joiner, Ribeiro, & Silva, 2012) and in NSSI (Klonsky, 2007). As long as this function can be provided by the latter, the need for the former is not as high.

But as in NSSI emotional relieve becomes stronger over time (Gordon et al., 2010), potentially even developing an addictive component (Blasco-Fontecilla et al., 2016; Groschwitz & Plener, 2012). If this relieve function – necessary for day to day life – fails, an individual will develop a profoundly elevated risk for completed suicide. NSSI afflicted individuals additionally have sufficient experience in self-harming to achieve completed suicide.

Meaning: The more established NSSI was beforehand, the lower is the link between suicide ideation and attempt, as ideation, in NSSI afflicted individuals, is stronger correlated with completed suicide on the one hand and evade suicide attempts, on the other hand.

Furthermore, it must be made clear that the basis of analysis is cross-sectional data. This means that it *cannot* be drawn from this that any single individual engaging in NSSI is more resilient against suicide/suicide attempts longterm. What *can* be drawn from this is that suicide attempts are less likely, in all individuals with suicide ideation and NSSI at one point in time.

To answer if an NSSI afflicted individual is getting more or less resilient against suicide (attempts), longitudinal data is needed.

The relation of NSSI and suicide ideation was another surprising result and requires more research, in particular of interest is how these interact. As a surprisingly high correlation between NSSI and suicide ideation of $r = .4$, was observed, which was comparable to the correlation between suicide ideation and attempts with $r = .43$.

It remains questionable, on basis of this analysis, if NSSI and suicide attempts differ, or are both the same, on one continuum.

Summary of evidence: Method

Variance specific moderation. As applying a variance specific moderation resulted in comparable results, to a moderation applied on all variances and not returning any warnings concerning model misfit, it is concluded that: Applying a moderator on a single variance is seen as possible, using OSMASEM.

Multiple moderators. Only limited conclusions can be drawn, for the use of multiple moderators. These limited conclusions are positive: As estimations of a single moderation effect is consistent, regardless of the amount of moderators modelled, given convergence.

An observation possible, as OSMASEM allows to extract multiple and single moderation effects. As such, using sex and age as an example, the moderation effect in the base study subset were -0.0015 and -0.031 respectively, or combined -0.032. These results can be reached by either introducing both moderators in a single model, or by adding the moderation effect estimation of two independent models and combing these.

From this consistency no conclusion can be made on the statistical validity of potential interaction effects or the validity of the resulting model estimation.

On Data distribution and reporting. When comparing the two study subsets for acquired capability for suicide, the original and the revised version, the differences in convergence were remarkable. With the original scale almost returned no converging result without model fit warnings, while the revised scale returned converging results without warnings, even when additionally applying sex or age as a moderator. Seen that both have the same amount of missings in the modelled matrix (25%) and the original scale had only k =2 less studies, this cannot be explained by data availability alone.

The only salient explanation for this difference in convergence, is the existence of – more – outliers in the original scale, than the revised scale; as outliers impact convergence negatively. These outliers might be in the correlation matrices themselves – though this would violate the MAR assumption – or in the moderator. The latter is more likely, as the original scale reported multiple versions, differing in item count. While the means of these were standardized to be comparable, errors in this process or misreporting in a study, such as Fox (2016), cannot be excluded. Moreover, a general loss of precision due to this standardization is to be expected, given that the smallest item count was five and the largest twenty.

As the effect of outliers in OSMASEM, both in the moderator and in the correlation matrix are not yet known, it is recommended that: To use study subsets with caution, as the impact of outliers is stronger, the lower the k.

With studies outside of MASEM, reporting that outliers impact FIML estimation (Zhong & Yuan, 2011) and outliers in moderator being reported to impact bi-variate meta-analytical estimations (Viechtbauer & Cheung, 2010) – a dedicated study investigating the impact of outliers in MASEM has not been found.

Fortunately, in this analysis, all study subsets using a specific moderator, had a related study

subset, allowing some internal control: For NSSI prevalence, existed NSSI-severity, for the original acquired capability for suicide scale, existed the revised version. Due to the – unplanned – internal control allowed such a observation, it is concluded that: In future, investigations into outliers should be done, for both moderators and correlations, before implementing any analysis. Moreover, as the potential bias is increased, the lower *k* this should be done for all subsets, relying on MAR is insufficient.

Reporting. A further conclusion on reporting can be drawn when including the subset for NSSI, in the observation to convergence and data availability. As this subset reported $k = 27$, with a comparable missings in the correlation matrix to both scales of the acquired capability for suicide, but 23% more missings in the modelled variances; with this the NSSI subset converged less then the revised scale, which had $k = 6$ less studies; implying that missings in the modelled matrix is more important then the total number of *k*.

Concluding from this: In MASEM the number of entries in the modelled variances is important, not the available data points in the matrix, or the number of studies. Reports should therefore differ in MASEM, from other meta-analysis and include additional or special reporting standards and an analysis for outliers, with a general focus on data in the modelled variances. For a proposition to MASEM reporting, see: Sheng et al., (2016).

OSAMSEM & TSSEM. Regarding the subject matter data availability, the question of using TSSEM or OSMASEM is important as both have inherent upsides and downsides.

While in practice OSMASEM seems more likely to impact future clinical research, as its ability to include continuous moderation is closer to common research interest: For now TSSEM is more applicable. As TSSEM is easier to implement and the output being easier to interpret, further TSSEM allows for fixed effect modelling, while OSMASEM inherently dis-allows fixed effect modelling. In short: TSSEM is the best choice in case no moderator is of interest.

If a moderator is of interest TSSEM is the best choice as long as enough data exists and the moderator can be split in subgroups logically and disregarding the difference between differential validity and predictive validity (Andersson, Cuervo-Cazurra, & Nielsen, 2014).

In TSSEM it is important to define the moderation values *a priori*. If the value(s) of the moderator are defined later, it would be impossible to prove, that the choice was theoretically sound not to achieve a desired outcome (*p*-hacked). In short, for TSSEM a pre-registration or pre-registered report must include *precise* information on where and why the moderation value is defined, to split the studies.

Limitation

Implementation

One Man Work. A number of limitations persist. First, as only one researcher was responsible for the entire research process, systematic errors cannot be excluded.

Still due to the large number of internal loops, both during systematic research – as a backward and forward search was applied on both platforms searched – as well as using two methods in the calculation phase, the TSSEM and the OSMASEM, the risk for systematic errors has been mitigated. The same one man work also limits the degree to which a systematic review can be presented, as with the amount of studies and the density of information – in each study – it was not feasible to do an in depth systematic review, including points like study quality estimations.

IPTS Model implementation. The simplistic implementation of the first the model part might be the cause for some of the reported results and maybe not observed, given a more comprehensive model implementation. As such this meta-analysis should mainly be seen as an evaluation of the second part of the model.

Cross-sectional design. As the IPTS is a predictive model for suicide, the use of cross-sectional data and not longitudinal data, might be inadequate. The use of cross-sectional data was seen as necessary. And *post fact* it was necessary, for the moderated models, likely not for the unmoderated models – in which an implementation using longitudinal data might be possible.
But as the moderation analysis was the main interest, cross-sectional data was used in each analysis to assure internal comparability.

Moderator implementation. For sex and age it is possible, that the non-significance is due to improper operationalization, compared to their theoretical role. With both age and sex on a theoretical bases being less moderators of differential prediction, but more moderators of differential validity (Andersson, 2014). Meaning that a TSSEM estimation is closer to the theoretical function of sex and age, than a OSMASEM estimation, the first subgrouping and the latter using a regression approach.

This view is supported, when comparing the almost significant p values returned by TSSEM, being $p = .051$ and $p = .052$, to those of OSMASEM, these being $p = .3$ and $p = .26$ respectively for sex and age. But as for TSSEM no precise cutoff points were defined *a-priori,* but created, with the goal to establish two comparably large subgroups – aiming for *REM* – it is likely that in a analysis with more theoretically sound cutoffs for age, (here: 20 years) and/or sex, (here:

50% male) results would be more or less significant. Stating that; statistical reliability of the moderation analysis to sex and age could not be obtained – as moderation points for age and sex were not *a-priori* defined.

Finally, at least for the 'moderator' NSSI a conundrum occurred. With a high correlation to the independent variable suicide ideation statistically implies mediation, not moderation, while mediation theoretically being ill-defined, as NSSI is per definition not involving suicide ideation (Baron & Kenny 1986). Pointing to a more complex relationship between NSSI and suicide ideation, beyond that of a simple moderator or mediator.

Data availability

Difference of suicide and NSSI. A notable weakness of the meta-analysis and potentially the IPTS was the apparent incapability to distinguish between nonsuicidal self-injury and suicide attempts, as the respective variances did not differ to suicide ideation. Though this observation is limited, as too few studies were found to answer what moderating qualities the scales for acquired capability for suicide had. As such, the model showed itself as predicting self-harm and not suicide attempts or nonsuicidal self-injury. This is in line with Joiners thought on suicide differing qualitatively from suicide attempts Joiner (2005 p.57f.) and could be the result of suboptimal implementation – using suicide attempts instead of suicide. Still, from an empirical standpoint, the use of suicide attempts as a substitute for suicide is the practical reality in suicide research, a model focused on operationalization should be able to accommodate such a reality.
Whereas the IPTS can only be validated or falsified by using all proposed variables and completed suicide as an outcome, the IPTS cannot be falsified, eliminating its main selling point: The ability to be tested.

Subsetting. As already pointed out, likely incorrect estimations emerged from the original acquired capability for suicide study subset. This must again be pointed out, as it was not just a limitation due to the data. The results also reflect on the currently implemented method.

In the package metaSEM two methods of estimating '*heterogeneity variance*' are currently implemented, – in R – called *expLog* and *sqSD,* only the first returns correct estimations, the latter returns converging results – seemingly incorrect – which to the author's best knowledge has not been noted previously. Likely the sqSD function is to be used in other implementable MASEM, within metaSEM. Furthermore, the second warning on *'invalid estimated variances'* is in metaSEM not noted as such, but only with a '!', behind the variance in question, which is easy to oversee. For

example in the case of this analysis the existence and importance of '!' only became clear by observing a R^2 =1 in a separate output and then backtracking the output, until observing a systematic relationship between these and the '!' notation – as such this the notation '!'.
Therefor the naming ‘invalid estimated variance’ is unique to this meta-analysis.

It is concluded that OSMASEM – in its current version – is not suited for practically minded researchers, but more appealing for statisticians; an observation supported by the reporting style of Jak and Cheung (in press).

Outlook and recommendations.

Subject matter. The IPTS could be of quite some use to improve our capability distinguish different forms of self-harm, as NSSI (Tschan, Lüdtke, Schmid, & In-Albon, 2019; Victor, Hipwell, Stepp, & Scott, 2019) and suicide attempts (You, Van Orden, & Conner, 2011) are often measured separately, as well as on a combined scores (Fässberg et al., 2012); enabling comparisons and aggregation.

With suicide ideation, suicide attempts and NSSI all being linked to social contentedness - in the IPTS expressed by thwarted belongingness and perceived burdensomeness- the IPTS is an apparent choice to frame further research to these variables. Envisioned, as establishing two forms of the IPTS: One for nonsuicidal self-injury and one for suicide (attempts), with the goal to make these as distinct as possible from one another, and thereby improving our discrimination ability and providing better guidances for practical intervention and risk evaluation.

First steps to this can be done, as such investigation is possible with the data of the current meta-analysis and could already be implemented. An additional meta-analysis would have to be made, using the studies already collected, by encompassing the following steps:

First, to locate all structural equation models, including NSSI and suicide ideation, or suicide attempts and suicide ideation and recording the individual path-models. Next, all models found would have to be implemented, using the current data; making testing confirmatory and systematic in nature, thereby evading multiple problematic limitations of SEM (MacCallum, Wegener, Uchino & Fabrigar, 1993;O’Boyle, et al., 2019). The product would thereby be a statistical replication of the path-models found within the studies and a semi-data driven, semi-exploratory investigation into the relations of the variables in question.

To the feasibility of this, a simple search was done yielding multiple applicable studies, (Chu, Rogers, & Joiner, 2016; Hamza et al., 2012; Miller, Esposito-Smythers, & Leichtweis, 2016).

Concluding on the IPTS. The main merit of the IPTS is the establishment of the desire–capability framework, so even if – in future – it is seen "[as] a storm in a water glass" (Hjelmeland & Loa Knizek, 2019), the statement of Klonsky remains true:

" . . . most often-cited risk factors for suicide distinguish poorly between those who attempt suicide and those who only consider suicide. " (Klonsky & May, 2014).

MASEM in future. The future of MASEM will likely include only random effects modelling and can already be observed, with MASEMS emerging like the Bayesian MASEM (Ke, 2019). The Bayesian MASEM allows to include single variances and (implicitly) continuous moderation - expanding the potential appliance of MASEM.

But a notable downside of all advancements in MASEM (and generally more complex methods), must be noted here: As with each new method, implementation becomes more a question of programming skill, while statistical soundness becomes more and more abstract.

In general the advancements in meta-analyses and MASEM are great, though some concern emerges, questioning if these advancements might not become counterproductive to our goal to better predict reality. As even today only few researcher can comprehend the statistical limits and faults of MASEMS completely(Cheung & Hafdahl, 2016). While assuredly hundreds or thousands can implement these procedures properly, implementation and sound critique are two different things.

If, in future the trend to disregard (basic) statistics continuous, a disregard warned against before (Sterling 1959; Lykken 1968) and the result observable today (Open Science Collaboration, 2015; Schimmack, 2020), new methods may only increase these diminishing effects.

As with increased complexity errors mount and criticism decreases, potentially leading to further diminishing our capability to predict reality and not increase it.

Concluding Remarks. I advised to welcome new methods, learn from them but don't disregard the basics in favour of 'the new shiny method'. The most dangerous thing in is the assumption of knowing 'the basics' (Oakes, 1986). As a rule: For every paper on a 'new shiny method', read one, on the basics.

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Appendix A

Table A.
Coding items, correlation matrices not included.

Type(paper=1, Thesis =0)	***SH-Prevalence(%)***	SI – Questioner	**TB Alpha**	SH-SD
Design	SA- Prevalence(%)	SH – . Questioner	**ACSS alpha**	SA-Mean
Number of matrices used	SI- Prevalence Typ	SA – Questioner.	SI-Range	SA-SD
n	**SH- Prevalence Typ**	TB-Questioner.	SH-Range (n of Items)	TB-Mean
%Male	SA- Prevalence Typ	PB-Questioner	SA-Range	TB SD
Mean-Age	SI-Measurment _Typ	**ACSS-Questioner**	TB-Range	PB Mean
Age SD	**SH- Measurment _Typ (0=Freq, 1= n of Method, 2 = Incident, 3= Multiple)**	**SI-Alpha**	PB-Range	PB SD
Pop source	SA-Measurment _Typ	**SH alpha**	ACSS-Range	***ACSS Mean***
Country	**SH(0) v. NSSI(1)**	**SA-Alpha**	SI-Mean	ACSS SD
SI-Prevalence %	**Alpha = cronbachs alpha**	**PB Alpha**	SI-SD	**SH Mean**

Note: **Bold** = Included in any analysis; ***Bold & Italicized*** = Included in TSSEM/OSMASEM analysis.