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Correlation of Medical Students' Situational Motivation and Performance of Non-Technical Skills During Simulation-Based Emergency Training

Dissertation

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Correlation of medical students' situational motivation and performance of non-technical skills during simulation-based emergency training

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Abstract

Background: Non-technical skills (NTS) are an indispensable element of emergency care and need to be prevalent alongside with good technical skills. Though, questions of how to teach (instructional design) and improve NTS effectively remain unresolved. One adjustment screw to enhance performance of NTS, which is detached from instructional designs and learning efforts might be motivation. Theoretical models and observational studies suggest that high levels of intrinsic (situational) motivation result in better performance and better learning. Therefore, this study analyzed the influence of motivation on performance of NTS, by exploring if high levels of intrinsic motivation lead to better performance of NTS in medical students.

Methods: In this prospective cross-sectional cohort study, the authors assessed the correlation of situational motivation and performance of NTS within a cohort of 449 undergraduates in their 1st to 4th year of medical studies, in a total of 101 emergency simulation trainings. Situational motivation was measured with the validated Situational Motivation Scale (SIMS), which was completed by every undergraduate directly before each simulation training. The NTS were evaluated with the Anesthesiology Students´ Non-Technical skills (AS-NTS) rating tool, a validated taxonomy, especially developed to rate NTS of undergraduates.

Results: Student situational motivation was weakly correlated with their performance of NTS in simulation-based emergency trainings.

Conclusion: Although motivation has been emphasized as a determining factor, enhancing performance in different fields and in medicine in particular, in our study, student situational motivation was independent from their performance of NTS in simulation-based emergency trainings (SBET).

Keywords: Non-technical skills, Simulation-based medical education, Motivation

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Background

High risk working places, like aviation or emergency-medicine, entail hazards for errors which can have disastrous consequences. Up to 80% of these adverse events are based on human factors [1].

To counter human errors in medicine, several training programs have been developed in the past – e.g. Anesthesia crisis resource management (ACRM), which emphasize cognitive and interpersonal skills, like communication, leadership, resource management and situational awareness [2]. These skills can be summarized as non-technical skills (NTS) [3, 4]. Over the past years, NTS have gained more attention and have been identified as inevitable for best patient care and safety [5, 6]. NTS are acquired through the socialization process of every human being and are heterogeneously distributed [7]. Despite the need to integrate teaching of NTS already in undergraduate medical education, current curricula usually do not address NTS in emergency training. Although some efforts were recently made to include teaching and assessment of NTS in undergraduate education, [8] it is not yet clear how this integration and which instructional designs might provide best learning outcomes.

Only few studies have investigated the effects of interventions like extensive debriefings or repeated exposures to simulation-based training, on performance and improvement of NTS [9, 10]. The questions of how NTS can be conveyed effectively and how performance of NTS can be improved remain unanswered. It is known that NTS are not necessarily promoted through clinical routine [11, 12] and therefore other adjustment screws than instructional designs should be identified.

Motivation presumably might be one determining factor in improving performance of NTS. That does not mean the motivation to learn NTS, as even high motivation to learn NTS might not result in better performance of NTS [13], because learning processes for achieving certain skills differ from classical factual learning (which can be mastered through diligence). Rather, the existing levels of individual motivation for engaging in activities could be an adjustment screw for enhancing performance of NTS. The positive impact of motivation on performance has been demonstrated in the past decades in several fields, e.g. psychology and education [14–17]. One of the leading motivation theories is the „Self Determination Theory "(SDT), described by Deci and Ryan [18], which has shown broad applicability and importance in medical education [13, 19, 20]. SDT postulates that humans have an innate will to grow, which can be supported or hampered by intrinsic or extrinsic factors or situations [21]. The growth is determined by the satisfaction of three basic psychological needs: autonomy, competency and relatedness [22]. In SDT, levels of motivation are described along a spectrum, with "intrinsic motivation" at one end and "amotivation" (having no motivation at all – when the person experiences a lack of competence or the reason for a task is not seen) at the other end [22]. Intrinsic motivation (the most autonomous form) is present, when activities are pursued for personal enjoyment, leading to inherent satisfaction. When external sources form the reason why an activity is carried out, extrinsic motivation is present. Extrinsic motivation has different levels of self-determination and autonomy: external, introjected, identified and integrated regulation [22]. The least autonomous regulation, *external regulated* behavior, is based on demands, punishment or possible rewards [23]. *Introjected regulation* is more autonomous than external, but the activity or rule is still seen as made by others and the activity is carried out to avoid guilt [24]. *Identified regulation* is more autonomous than *introjected regulation*. Here, the pursued activity is accepted as important and the person identifies itself with the task. The most autonomous regulation of extrinsic motivation is *integrated regulation*. Here, activities are connected to oneself [25]. All these motivations are present at a specific time, for a specific activity and therefore they are referred to as "situational motivation" [26].

Intrinsic, integrated and identified regulation are summarized as "autonomous self-regulation" and external and introjected regulation are summarized as „controlled self-regulation " [24]. In medical students, high levels of autonomous regulation or intrinsic motivation lead to better well-being, better learning and academic achievement [27, 28].

But, to our best knowledge, the correlation of medical students´ motivation and their performance of non-technical skills (NTS) in medical emergency training has not been described.

The undergraduate anesthesiology curriculum (1st to 4th year of medical studies) is, among other teaching units, composed of different anesthesiology/emergency simulation trainings, which build upon each other.

These trainings are interactive and focus on technical and non-technical skills.

In this prospective, observational cohort simulation study, we investigated the correlation of students´ motivation and their performance of NTS during simulation-based emergency training (SBET) in four cohorts of medical students.

We hypothesized that high levels of autonomous motivation might lead to better performance of NTS.

Methods

Study design and participants

We performed this prospective cohort simulation study, at the Department of Anesthesiology of the University

Medical Center Hamburg-Eppendorf, Germany, during the Winter semester 2018/19.

The undergraduate curriculum of the University Medical Center Hamburg- Eppendorf, is based on the spiral curriculum of Harden [29]. To foster learning, some teaching and learning goals are repetitively addressed and trained in consecutive semesters. This instructional design allows to reiterate and to extend the teaching contents and learning goals. Global learning objectives are composed of different lectures and training sessions of different disciplines, creating a learning module. Each module is assigned to its year of medical study (semester).

The undergraduate anesthesiology teaching units and trainings are designed since 2012, in the sense of the above mentioned learning spiral, to facilitate the retention of knowledge, through the constant repetition: Medical students of the University of Hamburg participate in their 1st to 4th year of medical studies in compulsory anesthesiology/emergency trainings, which build upon each other.

The 1st year students partake in one training session (Trauma training), the 2nd year students partake also in one training session (Advanced cardiac life support I), the 3rd year students in two training sessions (Advanced cardiac life support II and Operating room (OR) simulation) and the 4th year students partake in two training sessions (Advanced cardiac life support III (Respiratory emergencies, Cardiac emergencies)).

Each semester is divided into a lecture- and a lecture free period, followed by two examination weeks. The exams are scheduled after the lecture free period to provide enough time for each undergraduate to prepare for the semester exams.

The anesthesiology training sessions are all scheduled within the lecture period of the semester, in which all lectures and trainings of all assigned disciplines are conducted. No exams were scheduled near the time of the anesthesiology simulation trainings or other lectures.

Four hundred forty-nine students ($n = 182$ male, $n = 267$ female; 100%) in their 1st, 2nd, 3rd and 4th year of medical studies, who attended the compulsory anesthesiology/emergency simulation trainings, were included in the study. Motivation and NTS were assessed in a total of 101 trainings. A maximum of 17 students participated per training unit.

Anesthesiology and emergency trainings

Every simulation training has a set of standardized simulation scenarios, which are comparable regarding technical skills (TS) and non-technical skills (NTS). With each subsequent semester, the scenarios become more complex.

High fidelity simulators (Resusci Anne Laerdal) are used, which are suitable for training technical skills such as endotracheal intubation, defibrillation or drug administration. In each training, the undergraduates are divided into groups of three, rotating through the pre-set simulation scenarios. One of the undergraduates takes the role of the leading anesthesiologist/emergency physician and the other two of anesthetic co-workers. Each simulation scenario is supervised by the course instructor (an anesthesiologist who is experienced in medical education). After each simulation scenario, a debriefing on TS and NTS takes place.

Situational motivation of all participating students was assessed prior to each training session with the Situation Motivation Scale (SIMS) questionnaire [30]. NTS were assessed for the student taking the team-leader (anesthesiologist/emergency physician) role, using the "Anesthesiology Students´ Non-Technical Skills" (AS-NTS) rating tool [31]. Table 1 gives an overview of the number of included AS-NTS and SIMS assessments.

Assessment

SIMS – situation motivation scale

A translated version (German) [32] of the Situation Motivation Scale (SIMS) [30], adapted by Gillet et al. [26], was filled out by every student at the beginning of each training session. The SIMS measures the different types of motivation for an activity at a specific point of time. It examines the important question why the individual shows a certain behavior and engagement [33].

The adapted version of the SIMS has five sub-scales, with four items per subscale, measuring intrinsic motivation, external-, identified-, introjected regulation and amotivation. Each item has a 7-point Likert scale (1 = "*Does not correspond at all*" and 7 = "*Corresponds exactly*"). Students were asked to specify the degree to which each item represents a reason for them to participate in the training. A computed autonomous motivation index was calculated by adding and averaging the intrinsic motivation and identified regulation. A controlled motivation index was computed parallel to that by adding and averaging external- and introjected regulation [26, 30]. Validity and reliability of the SIMS, as well as the adapted version, have been supported in several studies [34].

Anaesthesiology students` non-technical skills (AS-NTS)

NTS were assessed by the AS-NTS evaluation sheet ("Anaesthesiology Students` Non-Technical skills") [31] which was filled in by the course instructor, who supervised the simulation scenario. All instructors were familiar with the AS-NTS, experienced in undergraduate medical education and working in anesthesiology and emergency medicine.

Table 1 Number of included AS-NTS ratings and SIMS questionnaires assessed in the winter semester 2018/19 at the University Medical Center Hamburg Eppendorf

	Total	1st year	2nd year	3rd year	4th year
SIMS questionnaires [a]	744	114	122	260	251
NTS ratings with corresponding SIMS questionnaires [b]	422	80	60	113	169

Abbreviation: AS-NTS Anaesthesiology Students'Non-Technical skills, *SIMS* Situational Motivation Scale, *NTS* Non-technical skills
[a] Data from 12 teaching units were incomplete and excluded from analysis
[b]A total of 422 AS-NTS ratings were completed. Only ratings of students who had filled out a complete corresponding SIMS questionnaire were analysed for the calculation of correlation

In AS-NTS, performance is rated on three dimensions. Each dimension (subscale has 5 items, which discriminate the performance on a five-point Likert scale (1 = "*very good*"; 5= "*very bad performance*"). An underlying skill structure is used to give behaviourally anchored rating examples ("*good*" or "*poor*").

AS-NTS provides single scores for each dimension, as well as computed sum score (AS-NTS_SUM) by adding the dimensions.

The dimensions of the AS-NTS are:

Dimension 1: Planning tasks, prioritizing and conducting
Dimension 2: Teamwork: exchanging information and leading the team
Dimension 3: Team orientation

Reliability and validity of AS-NTS have been previously supported [31].

Statistical analysis

Statistical analysis was performed with SPSS (version 23.0, IBM Corp., Armonk, New York, USA). Descriptive statistics were used to describe the levels of reported motivational qualities. Mean differences in motivation and NTS were compared by year of medical school with analysis of variance (ANOVA). Significant differences between the different groups were analyzed by a follow-up post hoc test (Bonferroni correction). The Pearson correlation coefficient was used in order to test independence between motivation and performance of NTS.

Internal consistency of the adapted German SIMS version was analyzed, calculating Cronbach alpha for each sub-scale.

Results

Situational motivation

All students reported to be predominantly autonomously motivated with corresponding low levels of external regulation (Table 2). Comparing the year of their study,

Table 2 Means (standard deviation) and ANOVA results of different situational motivational and AS-NTS scores of different year undergraduates, assessed in the winter semester 2018/19 at the University Medical Center Hamburg Eppendorf

Situational Motivation	1st year	2nd year	3rd year	4th year	ANOVA			Crohnbach alpha
					F (df)	p	η^2	
Intrinsic	5.87 (.81)	6.00 (.63)	5.85 (.76)	5.85 (.80)	1.23 (3)	.27	.005	.76
Identified	5.70 (.81)^{B}	5.91 (.81)^{A}	5.39 (1.13)^{A}	5.36 (1.18)^{AB}	9.67 (3)	.000*	.04	.68
Introjected	2.88 (1.17)	2.84 (1.28)	2.78 (1.27)	2.84 (1.33)	.23 (3)	.88	.001	.74
Extrinsic	1.89 (.90)	1.85 (1.02)	1.76 (.83)	1.82 (.88)	.66 (3)	.58	.003	.78
Amotivation	1.56 (.82)	1.42 (.59)	1.48 (.74)	1.43 (.68)	1.30 (3)	.27	.005	.75
Motivational Indices								
Autonomous	5.78(.70)	5.95(.61)^{A}	5.62(.84)^{A}	5.60 (.88)^{A}	4.49 (3)	.000*	.003	
Controlled	2.38 (.86)	2.34 (1.04)	2.27 (.86)	2.33 (.91)	.53 (3)	.66	.002	
AS-NTS								
Dim_1	2.29(.83)	2.2 (1.01)	2.00(.86)	1.95(.81)	2.87 (4)	.023*	.02	
Dim_2	2.24(.83)	2.18(.90)	1.94(.90)	1.93(.83)	2.87 (4)	.023*	.02	
Dim_3	2.19(.80)	2.24 (1.04)	1.92(.89)	1.84(.78)	5.00 (4)	.001*	.04	
Sum score	6.73 (2.20)	6.62 (2.76)	5.86 (2.43)	5.69 (2.01)	4.50 (4)	.001*	.04	

Abbreviations: Dim = dimension
*$p < 0.05$ A Post-hoc analysis with Bonferroni-correction for multiple testing revealed that 2nd years´ levels of identified motivation and levels of autonomous regulation was significantly higher than 3rd and 4th year students ($p < .000$). B Furthermore, 1st year students were significantly higher on identified levels of motivation than 4th year students ($p < .000$). AS-NTS scores of 4th year students were significantly better than first year students on all three dimensions and on the sum score ($p = .023; .023; .001; .001$)

different year medical students reported varying qualities of situational motivation (Table 2). 2nd year students´ levels of identified motivation and levels of autonomous regulation were significantly higher than 3rd and 4th year students ($p < .000$). Furthermore, 1st year students were significantly higher on identified levels of motivation than 4th year students ($p < .000$) (Table 2).

Correlation of students´ situational motivation and NTS

Amotivation was weakly correlated to poor performance on dimension one (planning tasks, prioritizing and conducting, $p = .04$) and to the sum score of AS-NTS ($p = .04$). Furthermore, identified regulation ($p = .01$) and autonomous motivation ($p = .03$) showed a weak correlation to poor performance on dimension three of AS-NTS (Team orientation). These results were statistically significant but not relevant (Table 3) because the correlation was very weak (r below 0.3). Weak correlations might be statistically significant but they do not have any informational value [35].

The scores for all NTS dimensions, measured by the AS-NTS, showed a progress in NTS over the years (decrease in scoring = better performance, 1 = *"very good"*; 5= *"very bad performance"*). AS-NTS scores of 4th year students were significantly better than first year students on all three dimensions and on the sum score (Table 2).

Discussion

In this study, high levels of autonomous situational motivation of students did not correlate with better performance of NTS in simulation-based emergency training.

The urgent need to focus early on NTS in medical education and training has been emphasized and therefore strategies to foster learning NTS should be identified [8]. We hypothesized, that next to instructional designs focusing on NTS, motivation might to be a determining factor that could enhance performance of NTS in undergraduates. Previous findings in the field of motivation showed that students with high motivation achieve higher academic degrees [28], score higher on the grade point average (GPA), are more productive in small group tutorials [36, 37] and achieve greater academic success through higher study effort [17]. The results of our study do not support the positive correlation of high levels of autonomous motivation and performance of NTS in students during simulation-based emergency training. Although all investigated students reported high levels of autonomous motivation, no impact on their performance of NTS was found.

One explanation for the results is that high levels of autonomous motivation might lead to deeper learning, more effort and consequently better scores in tests requiring factual knowledge [17, 38], but autonomous motivation might have no influence on performance which requires a transfer of knowledge to action [39].

Good performance of NTS requires indeed transferring effort (factual knowledge of skills has to be put in practice) and hence, our findings do not support the predictability of motivation regarding students` performance (NTS). Acquiring NTS is an ongoing process, which might be detached from the classical, factual learning approach- an approach which has been supported to have a positive correlation with motivation.

One strength of our study is the scrutinization of the correlation between motivation and performance of NTS in different year medical students, leading to more representative results than just investigating one cohort of undergraduates at one point of their medical studies. Hereby, possible time and study dependent alterations of motivation did not falsify our results.

Although the situational motivation within the investigated group of students was distributed heterogeneously, still no effect on performance of NTS was discovered.

The 2nd year students reported significantly higher levels of identified regulation and autonomous motivation, compared with the 3rd and 4th year students. The 1st year students showed higher levels of identified regulation than 4th year students. One possible explanation is that the 3rd and 4th year students might have reached a certain state of boredom and therefore do not identify themselves with the simulation trainings anymore.

Table 3 Correlation of NTS and SIMS scores assessed during simulation-based emergency training in the winter semester 2018/19 at the University Medical Center Hamburg Eppendorf

DIM1 *r*=	Situational Motivation					Motivation Indices	
	Intrinsic .005	Identified .078	Introjected .048	Extrinsic .034	Amotivation .101*	Autonomous .054	Controlled .051
DIM2 *r*=	−.022	.026	.028	.031	.089	.009	.035
DIM3 *r*=	.047	.122*	.093	.045	.082	.104*	.088
SUM *r*=	.011	.084	.063	.041	.101*	.062	.065

Abbreviations: *r* Pearson correlation Coefficient
DIM Dimension of the AS-NTS rating tool
SUM Sum of the AS-NTS rating tool score
*$p < 0.05$

Boredom has shown to have a fading effect on intrinsic and identified regulation and thus autonomous motivation [40]. It can therefore be concluded that in order to prevent a decrease in autonomous motivation, repetitive exposure to SBET should be utilized advisedly.

One explanation for the fact that we did not detect a correlation between situational motivation and performance of NTS might be the partial homogeneity of our investigated group, regarding their levels of situational motivation. Further studies should analyze the effect of situational motivation on NTS, in different groups with different starting values of motivation.

We preferred the application of the SDT over other motivational theories, because the applicability and importance of SDT in medical education has been supported previously [19, 41]. The assessment of situational motivation, which is described in SDT, enables the comparison of different and repeated measurements [15]. That means one can measure the motivation to engage in a specific activity at an exact time point. Hereby, the motivational measures were narrowed to the emergency trainings to prevent biased results [33]. The reported levels of motivation were comparable in all investigated groups, which might lead to the assumption, that the SIMS was not able to assess adequately the motivational levels. But, as the SIMS has proven in several studies to be a reliable tool [26, 30], we believe that the investigated undergraduates had high levels of motivation and low levels would have been detected.

Conclusion

In this study, high levels of autonomous situational motivation of students did not correlate with better performance of NTS in simulation-based emergency training. Therefore, enhancing medical students´ intrinsic motivation will not foster learning of NTS. Other teaching approaches need to be identified to improve performance of NTS.

Limitations

Our prospective study was conducted in a cross-sectional design and therefore we did not analyze intra-individual variances.

Abbreviations

NTS: Non-technical skills; SDT: Self-determination theory; AS-NTS: Anaesthesiology students´ non-technical skills; SIMS: Situational motivation scale

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Authors' contributions

L-SU made substantial contributions to conception and design, acquisition of data, analysis and interpretation of data. She has been involved in drafting the manuscript and given final approval of the version to be published. She agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. *JS-C* made substantial contributions to acquisition of data. He has been involved in revising the manuscript critically for important intellectual content and has given final approval of the version to be published. He agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. *CZ* made substantial contributions to conception and design, analysis and interpretation of data. He has been involved in drafting the manuscript and revising it critically for important intellectual content. He has given final approval of the version to be published. He agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. *JC-K* made substantial contributions to acquisition of data. He has been involved in revising the manuscript critically for important intellectual content and has given final approval of the version to be published. He agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. *SS* made substantial contributions to acquisition of data. She has been involved in revising the manuscript critically for important intellectual content and has given final approval of the version to be published. She agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. *P-MK* made substantial contributions to conception and design, analysis and interpretation of data. She has been involved in drafting the manuscript and revising it critically for important intellectual content. She has given final approval of the version to be published. She agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The local Ethic Committee of Hamburg (Ethikkommission der Ärztekammer Hamburg, Hamburg, Germany) was contacted with a detailed project description and the head of the committee rated the study with humans but not on humans and therefore did not see any necessity of deliberation and classified the project as not appropriate for ethic consultation (§ 9 des Hamburgischen Kammergesetzes für Heilberufe).
Participation in the study was voluntary and written informed consent was obtained from each participant.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests" in this section.

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Publisher's Note

2 Abbreviations

AS-NTS	- Anaesthesiology Students' Non-Technical Skills Rating Tool
NTS	- Non-technical skills
SBET	- Simulation-based emergency training
SDT	- Self-determination theory
SIMS	- Situational Motivation Scale
TS	- Technical skills

3 Summary of the Publication

3.1 Background

Human factors are the basis for the majority of adverse events in high risk working places such as emergency medicine (Cooper et al. 1978). **Non-technical skills (NTS)** as described by Flin and Patey (2009) are “the cognitive, social and personal resource skills that complement **technical skills (TS)** and contribute to safe and efficient task performance”. NTS are essential for counteracting errors that arise from these human factors. Examples of NTS include communication, leadership, resource management and situational awareness (Gabe et al. 2001). NTS improve patient safety (Flin and Patey, 2009). It has been shown that clinical routine alone does not guarantee the development of NTS (Yee et al. 2005, Zausig et al. 2009), possibly because the learning process for achieving NTS differs from the diligence-based process required for classical factual learning. A recent meta-analysis by Greif et al. (2020) in the domain of cardiopulmonary resuscitation training showed a lack of evidence with respect to the impact of specific NTS training interventions. It is therefore crucial to identify factors that enhance the development of NTS and implement them in medical training. Stewart and Barrick (2000) postulated that NTS are acquired through the socialisation process of every human being and are inhomogeneously distributed. Whilst the importance of NTS has been confirmed, it is still not known how best to train NTS in undergraduates (Weinger 2007).

One key to enhancing the performance of NTS might be motivation. Since the **"self-determination theory" (SDT)** was introduced by Deci and Ryan in 1985, several subsequent studies have been conducted to determine if the predictions of the SDT are reproducible in real life settings. These studies proved the integral relationship of intrinsic motivation and learning in an academic setting (Kursakur et al. 2011, Kursakur 2019, ten Cate et al. 2011, Williams et al. 1999). Furthermore, intrinsic and autonomous motivation were associated with greater outcomes (such as higher academic achievements, less drop-out and more investment in studying) in several fields such as general education, healthcare, workplace satisfaction and competitive sport (Gillet et al. 2013, Kusurkar R et al. 2011, ten Cate et al. 2011).

In the field of medical education, SDT has been seen as one of the leading theories of how motivation impacts performance and has been extensively cited in the literature (ten Cate 2011, Van der Burgt 2018, Wang 2001, Williams 1997). SDT is based on the premise that human beings inherently yearn to, psychologically, grow. This growth is affected positively and negatively by both internal and external factors or situations. This growth is further impacted upon by three basic psychological needs: autonomy, competency and relatedness. Individual behaviour can be guided by motivation, which can be divided into various forms/qualities and described along a spectrum. At the higher or favourable end of the spectrum is “intrinsic motivation”, at the lower or unfavourable end is “amotivation”. The following terms and examples are adapted from the original article (page 6 of this manuscript):

1. **Intrinsic motivation** is present, when activities are pursued for personal enjoyment, leading to inherent satisfaction. This is the most autonomous form of motivation.
2. **Extrinsic motivation** is present, when external sources form the reason why an activity is carried out. Extrinsic motivation is subdivided into (in descending order of autonomy):
    2.1. **Integrated regulation**, where an activity is connected to oneself.
    2.2. **Identified regulation**, where an activity is accepted as important and the person identifies with the task.
    2.3. **Introjected regulation**, where an activity or rule is seen as being made by others and the activity is carried out to avoid guilt.

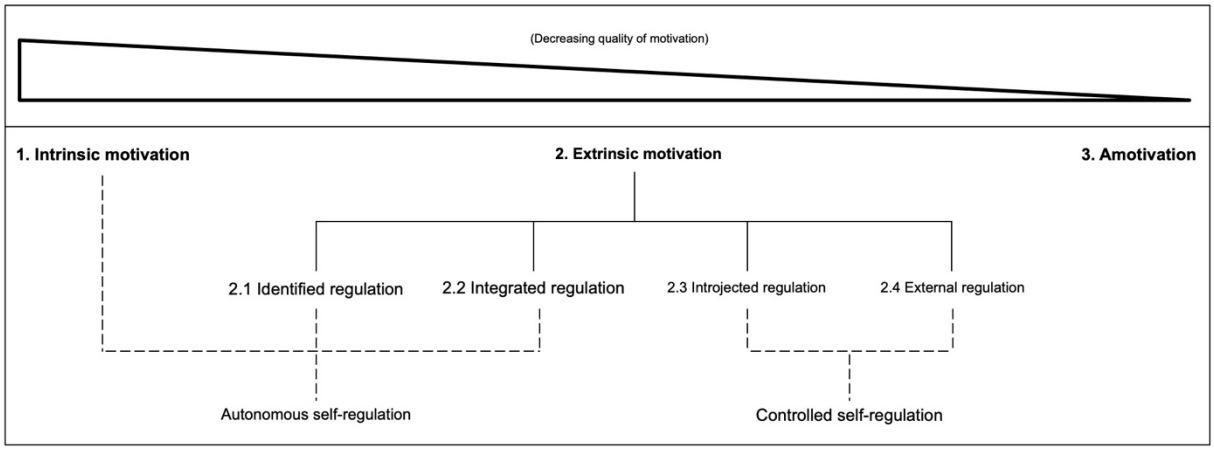
External regulation, where an activity is completed based on demands, punishment or possible rewards.

3. **Amotivation** is present, when there is a complete lack of motivation. The reason for an activity or task is not recognised, or the person experiences a lack of comprehension for the task’s necessity.

Deci et al. (1994) further grouped intrinsic motivation, integrated regulation and identified regulation together into “**autonomous self-regulation**”. Introjected regulation and external regulation are grouped together as "**controlled self-regulation**".

Figure 1

A depiction of motivation and regulation along a decreasing spectrum of autonomy



Note: adapted from [Deci E, Ryan RM (1985). Intrinsic motivation and self-determination in human behaviour. Springer Science & Business Media].

The distribution and weighting of different types (or qualities) of motivation is dynamic and changes depending on context, time, and activity. The term “**situational motivation**” reflects its fluid nature and can be measured using the **Situational Motivation Scale (SIMS)** developed by Guay, Vallerand and Blanchard in 1997 (described in further detail in section 3.2.3.1, page 18).

Sobral showed in 2004 that in medical students, high levels of autonomous self-regulation (which reflect a tendency towards intrinsic motivation) lead to better well-being, better learning and higher academic achievement. To the best of our knowledge, the correlation between medical students’ motivation and their performance of NTS, specifically in medical emergency training, has not yet been described in the literature. In accordance with the predictions of SDT, we hypothesised that high levels of autonomous motivation has a positive influence on the performance of NTS.

3.2 Methods

For a detailed description of the methodology and study design, please refer directly to the original article on pages 6 to 8 of this manuscript.

3.2.1 Study Design and Participants

This prospective cohort study was conducted in the Department of Anaesthesiology at the University Medical Center Hamburg-Eppendorf, Germany, during the winter semester of 2018/19.

The Ethics Committee of the Hamburg Medical Council (Ethikkommission der Ärztekammer Hamburg, Hamburg, Deutschland) was contacted with a detailed project description. The study was approved without the need for further deliberation. Eligible students were informed per email of the study and their participation was requested. Involvement in the study was completely voluntary. Written, informed consent was obtained from each willing participant.

The undergraduate programme at Universität Hamburg (the University of Hamburg) is a spiral curriculum, as described by Harden and Stamper (1999), where the retention of newly acquired knowledge is supported through repetition and continuity. Medical students in their 1st to 4th years participate in anaesthesiology/emergency medicine training sessions which build upon each other in complexity in subsequent years. The learning modules are divided into a lecture part and practical **simulation-based emergency training (SBET)** part as follows:

- 1st year: one training session (trauma training).
- 2nd year: one training session (advanced cardiac life support part I).
- 3rd year: two training sessions (advanced cardiac life support part II; operating theatre simulator).
- 4th year: two training sessions (advanced cardiac life support part III, respiratory emergencies; advanced cardiac life support part III, cardiac emergencies).

449 students (n = 182 male, n =267 female; 100%) in their 1st, 2nd, 3rd and 4th year of medical school were included in the study. Motivation and NTS were assessed over a total of 101 training sessions.

3.2.2 Anaesthesiology and Emergency Medicine Trainings

Each training session was comprised of a theoretical and practical part. The complexity of the material and scenarios increased from semester to semester (in accordance with the spiral curriculum concept), requiring increasing competence in TS and NTS. High fidelity simulators (Resusci Anne Laerdal) suitable for the training of TS (such as endotracheal intubation, defibrillation, cardiopulmonary massage) were used for the practical part of each session.

The **Situational Motivation Scale (SIMS)** questionnaire (described in detail in section 3.2.3.1, page 18) was completed by each participant at the beginning of each training session. The undergraduates participated thereafter in the standardised lecture (the theoretical part of the training session), in the form of a traditional PowerPoint presentation lead by one of the lecturers. A short break followed.

The second part of the training session (the practical part) began with the students being divided into groups of three, rotating through pre-set, standardised simulation scenarios. One of the undergraduates took the role of the leading anaesthesiologist/emergency physician (team leader) and the other two students took the roles of competent co-workers (team members). An anaesthesiologist with experience in medical education guided and supervised the simulation. On completion of the simulation scenario, a debriefing with the team was conducted before the student groups rotated to another standardised simulation with a different instructor. The supervising anaesthesiologist assessed the team leaders in each scenario, using the "**Anaesthesiology Students' Non-Technical Skills Rating Tool" (AS-NTS)** (described in further detail in section 3.2.3.2, page 18), developed by Moll-Khosrawi et al. and validated in 2019. The students did not receive feedback related to their AS-NTS scores, so as to reduce bias in future assessments.

3.2.3 Assessment

3.2.3.1 Situational Motivation Scale (SIMS)

Each student completed a validated German version of the SIMS at the start of each learning session (included as supplementary material, section 8.1, page 28). Twenty questions pertaining to the degrees of intrinsic motivation, external regulation, identified regulation, introjected regulation and amotivation are assessed with a 7-point Likert scale (1 = ‘‘*does not correspond at all*’’ and 7 = ‘‘*corresponds exactly*’’). To minimise bias, the questions were not grouped according to type of motivation.

Two indices were calculated automatically:

1. **Autonomous motivation index** (intrinsic motivation and identified regulation).
2. **Controlled motivation index** (external and introjected regulation).

The original English version of the SIMS (without Likert scale) is included for comparison as supplementary material in section 8.2, page 29.

3.2.3.2 Anaesthesiology Students' Non-Technical Skills Rating Tool (AS-NTS)

The supervising anaesthesiologist assessed NTS using the Anaesthesiology Students' Non-Technical Skills Rating Tool (AS-NTS) evaluation sheet. The AS-NTS is divided into three dimensions on a five-point Likert scale (1= "*very good performance"*; 5= "*very bad performance"*):

- Dimension 1: Planning tasks, prioritizing and conducting.
- Dimension 2: Teamwork, exchanging information and leading the team.
- Dimension 3: Team orientation.

The translated (German) version of the AS-NTS is included as supplementary material in section 8.3, page 30. The original English version of the AS-NTS is also included (section 8.4, page 31).

3.2.3.3 Statistical Analysis

The Statistical Package for Social Sciences (SPSS) was used to analyses our findings. Descriptive statistics were used to present reported motivational qualities. Analysis of

Variance (ANOVA) was used to compute mean differences in motivation and NTS as compared by year of study. The Bonferroni correction was used to analyse significant differences between the different groups (post-hoc). The Pearson correlation coefficient (*r*) was applied to motivation and performance of NTS to measure linear correlations. Cronbach's alpha was used to assess internal consistency of the adapted German SIMS. A two-tailed $p < 0.05$ was considered to be statistically significant. Nominal p-values are reported without correction for multiplicity.

3.3 Results

3.3.1 Recruitment of Volunteers

Table 1 summarises the total number of individual SIMS questionnaires answered, as well as the number of those that had corresponding NTS Ratings.

Table 1

Number of Included AS-NTS Ratings and SIMS Questionnaires Assessed in the Winter Semester 2018/19 at the University Medical Center Hamburg-Eppendorf

	Total	1st year	2nd year	3rd year	4th year
SIMS questionnaires[a]	744	114	122	260	251
NTS ratings with corresponding SIMS questionnaires[b]	422	80	60	113	169

Abbreviations: *AS-NTS* Anaesthesiology Students' Non-Technical Skills Rating Tool, *SIMS* Situational Motivation Scale, *NTS* Non-technical Skills

[a] Data from 12 teaching units were incomplete and excluded from analysis

[b] A total of 422 AS-NTS ratings were completed. Only ratings of students who had filled out a complete corresponding SIMS questionnaire were analyzed for the calculation of correlation

Note: Adapted from [Schulte-Uentrop L, *et al.* (2020) Correlation of medical students' situational motivation and performance of non-technical skills during simulation-based emergency training. *BMC Med Educ.* 20, 351].

3.3.2 Situational Motivation

Medical students in all years of study reported high levels of autonomous motivation and low levels of external regulation. 2nd year students reported the highest levels of autonomous motivation. 1st year students reported higher levels of all types of motivation compared with 4th year students. Table 2 depicts the breakdown of results.

Table 2

Means (Standard Deviation) and ANOVA Results of Different Situational Motivational and AS-NTS Scores of Different Year Undergraduates, Assessed in the Winter Semester of 2018/19 at the University Medical Center Hamburg-Eppendorf

	1st year	2nd year	3rd year	4th year	ANOVA			Cronbach's alpha
					F (df)	p	η^2	
Situational Motivation								
Intrinsic	5.87 (.81)	6.00 (.63)	5.85 (.76)	5.85 (.80)	1.23 (3)	.27	.005	.76
Identified	5.70 (.81)[b]	5.91 (.81)[a]	5.39 (1.13)[a]	5.36 (1.18)[ab]	9.67 (3)	.000*	.04	.68
Introjected	2.88 (1.17)	2.84 (1.28)	2.78 (1.27)	2.84 (1.33)	.23 (3)	.88	.001	.74
External	1.89 (.90)	1.85 (1.02)	1.76 (.83)	1.82 (.88)	.66 (3)	.58	.003	.78
Amotivation	1.56 (.82)	1.42 (.59)	1.48 (.74)	1.43 (.68)	1.30 (3)	.27	.005	.75
Motivational Indices								
Autonomous	5.78 (.70)	5.95 (.61)[a]	5.62 (.84)[a]	5.60 (.88)[a]	4.49 (3)	.000*	.003	-
Controlled	2.38 (.86)	2.34 (1.04)	2.27 (.86)	2.33 (.91)	.53 (3)	.66	.002	-
AS-NTS								
Dim_1	2.29 (.83)	2.2 (1.01)	2.00 (.86)	1.95 (.81)	2.87 (4)	.023*	.02	-
Dim_2	2.24 (.83)	2.18 (.90)	1.94 (.90)	1.93 (.83)	2.87 (4)	.023*	.02	-
Dim_3	2.19 (.80)	2.24 (1.04)	1.92 (.89)	1.84 (.78)	5.00 (4)	.001*	.04	-
Sum score	6.73 (2.20)	6.62 (2.76)	5.86 (2.43)	5.69 (2.01)	4.50 (4)	001*	.04	-

Abbreviations: *Dim_* Dimension of the AS-NTS Rating Tool
*$p < 0.05$
[a] Post-hoc analysis with Bonferroni-Correction for multiple testing revealed that 2nd year students' levels of identified motivation and levels of autonomous regulation were significantly higher than 3rd and 4th year students ($p < .000$).
[b] 1st year students were significantly higher on identified levels of motivation than 4th year students ($p < .000$). AS-NTS scores of 4th year students were significantly higher than first year students on all three dimensions and on the sum score ($p = .023; .023; .001; .001$).

Note: Adapted from [Schulte-Uentrop L, *et al.* (2020) Correlation of medical students' situational motivation and performance of non-technical skills during simulation-based emergency training. *BMC Med Educ.* 20, 351].

3.3.3 Correlation of Students' Situational Motivation and NTS

Amotivation showed a statistically significant but weak correlation to poor performance in Dimension 1 of the AS-NTS (planning tasks, prioritising and conducting). Identified regulation and autonomous motivation showed a weak correlation to poor performance in team orientation (Dimension 2 of the AS-NTS). These results were, however, not relevant, as the Pearson correlation coefficient was low (<0.3). Table 3 summarises the results. To note is that AS-NTS scores improved over the years with the best scores attained by 4th year students (see Table 2).

Table 3

Correlation of NTS and SIMS Scores Assessed During Simulation-Based Emergency Trainings in the Winter Semester 2018/19 at the University Medical Center Hamburg-Eppendorf

	Situational motivation					Motivation indices	
	Intrinsic	Identified	Introjected	External	Amotivation	Autonomous	Controlled
DIM1 r =	.005	.078	.048	.034	.101*	.054	.051
DIM2 r =	−.022	.026	.028	.031	.089	.009	.035
DIM3 r =	.047	.122*	.093	.045	.082	.104*	.088
SUM r =	.011	.084	.063	.041	.101*	.062	.065

Abbreviations: r Pearson Correlation Coefficient, *DIM:* Dimension of the AS-NTS rating tool, *SUM:* Sum of the AS-NTS rating tool score
*p < 0.05

Note: Adapted from [Schulte-Uentrop L, *et al.* (2020) Correlation of medical students' situational motivation and performance of non-technical skills during simulation-based emergency training. *BMC Med Educ.* 20, 351].

3.4 Discussion

In our study, we found that the performance of NTS does not correlate with high levels of autonomous motivation, thus failing to prove our hypothesis as predicted by the self-determination theory. This leads us to continue the urgent need to find and develop other strategies and methods that do not necessarily involve motivation-based interventions to be developed to improve NTS during undergraduate studies.

We did find that the performance of NTS in SBET improved with increase in year of study, with 4th year students having the lowest (best) scores in all 3 dimensions of the AS-NTS. Pelaccia and Viau (2017) write that highly motivated medical students use more effective learning strategies. Some of these strategies could include the "transfer

of knowledge to action" strategies needed for acquiring NTS. We postulate that these "transfer of knowledge" strategies are learned and practiced over time, which would correlate with the above results. Motivation based strategies should therefore not be excluded in the search to improve the acquisition of NTS, as high levels of autonomous motivation improve performance of learning in general and thus indirectly improve the ability to acquire NTS.

We have confirmed high levels of autonomous motivation in our medical student population. It is possible that the homogeneity of motivation in our study group lead to our results not being able to detect a correlation between situational motivation and performance of NTS. The results of our study cohort confirm those of other studies showing that medical students are generally highly motivated (described in section 3.1, page 15), which makes it challenging to see the effect of the underrepresented, poorly motivated students on the performance of NTS. Further studies could analyse subgroups with a more heterogenous spread of motivation. The homogeneity of motivation levels might also lead to the assumption that the SIMS is an ineffective tool for differentiating types of motivation accurately. However, the SIMS has been validated and thus proven to be reliable and we believe the results are representative of our cohort.

Amotivation correlated to poorer performance on Dimension 1 of the AS-NTS (planning tasks, prioritizing and problem solving) and on the overall performance of NTS. These results are not surprising, as they correspond with the predictions of SDT. We found that high levels of identified regulation and autonomous motivation correlated to poorer performance on Dimension 3 of the AS-NTS (team orientation). These results, although statistically significant, showed only weak levels of correlation (r below 0.3) and were therefore not relevant.

A strength of our study is the comparison of motivation to performance across 4 years of students rather than a single cohort, allowing us to investigate the potential bias that time may have on study-dependent changes in motivation. For example, 3rd and 4th year students had lower levels of identified regulation and autonomous motivation

compared to students in their first 2 years of study, possibly indicating the attainment of a certain state of boredom with the education process itself through the repetition of content over several years in accordance with the spiral curriculum. Boredom leads to decreases in autonomous motivation (Kusurkar et al. 2012). We conclude that repetitive SBET may increase boredom with resulting decreases in autonomous motivation. Care should be taken to avoid an overuse of SBET in learning programmes.

Boredom may have additionally confounded our results with respect to the completion of the SIMS questionnaire itself. We noted that some individual students who completed a series of SIMS showed a tendency to give more neutral answers over time. That is, the SIMS became more homogeneously completed across the 7-point Likert scale favouring the variable 4 as the median value on the scale. Whilst this could reflect an accurately completed SIMS, we cannot exclude boredom with the completion process of the SIMS as a confounder, resulting in a reduction in the accuracy of the assessed situational motivation in isolated participants.

4 Conclusion

In this prospective cohort study, we show that medical students have high levels of autonomous situational motivation. However, this did not correlate with better performance of non-technical skills in simulation-based emergency training. Based on this finding, encouraging and targeting medical students' intrinsic motivation will not necessarily lead to improvements in acquiring and enhancing non-technical skills. Repeatedly practicing NTS allows for the development of these skills, whilst overuse of SBET should be avoided so as to reduce boredom and its adverse effects on motivation, leading to a reduction in the quality of performance in other areas of learning where motivation impacts greatly. Other teaching approaches should be developed or adapted to foster the advancement of essential non-technical skills and cultivate greater learning.

5 Summary

Background: Non-technical skills (NTS) are an indispensable element of emergency care and need to be prevalent alongside with good technical skills. Though, questions of how to teach (instructional design) and improve NTS effectively remain unresolved. One adjustment screw to enhance performance of NTS, which is detached from instructional designs and learning efforts might be motivation. Theoretical models and observational studies suggest that high levels of intrinsic (situational) motivation result in better performance and better learning. Therefore, this study analyzed the influence of motivation on performance of NTS, by exploring if high levels of intrinsic motivation lead to better performance of NTS in medical students.

Methods: In this prospective cross-sectional cohort study, the authors assessed the correlation of situational motivation and performance of NTS within a cohort of 449 undergraduates in their 1st to 4th year of medical studies, in a total of 101 emergency simulation trainings. Situational motivation was measured with the validated Situational Motivation Scale (SIMS), which was completed by every undergraduate directly before each simulation training. The NTS were evaluated with the Anesthesiology Students´ Non-Technical skills (AS-NTS) rating tool, a validated taxonomy, especially developed to rate NTS of undergraduates.

Results: Student situational motivation was weakly correlated with their performance of NTS in simulation-based emergency trainings.

Conclusion: Although motivation has been emphasized as a determining factor, enhancing performance in different fields and in medicine in particular, in our study, student situational motivation was independent from their performance of NTS in simulation-based emergency trainings (SBET).

6 Zusammenfassung

Hintergrund: Psychosoziale Fertigkeiten sind ein unverzichtbarer Bestandteil der Notfallmedizin und sollten praktische Fertigkeiten ergänzen. Dennoch gibt es bisher kein gutes Konzept, wie man psychosoziale Fertigkeiten lehren (didaktisch) und verbessern kann. Eine Stellschraube (Möglichkeit) um psychosoziale Fertigkeiten zu verbessern, unabhängig von didaktischen Konzepten, könnte die Motivation der Studierenden sein. Theoretische Modelle und Beobachtungsstudien suggerieren, dass eine hohe intrinsische (situativ) Motivation zu besseren Ergebnissen führen. Daher befasst sich diese Studie mit dem Einfluss von Motivation auf die Ausprägung von psychosozialen Fertigkeiten im notfallmedizinischen Simulationsunterricht, erhoben bei Studierenden der Medizin.

Methodik: In dieser prospektiven Längsschnitt-Kohortenstudie wurde die Korrelation von situatiativer Motivation und der Ausprägung von psychosozialen Fertigkeiten, in insgesamt 101 Notfallsimulationstrainings in einer Kohorte von 449 Medizinstudenten (1. - 4. Jahr) untersucht. Die Ausprägung der situativen Motivation wurde anhand eines validierten Erhebungsbogens, dem "Situation Motivation Scale" (SIMS), erhoben, welche von jedem Studenten direkt vor Beginn des Notfalltrainigs ausgefüllt wurde. Die psychosozialen Fertigkeiten wurden durch das Anaesthesiology Students´ Non-Technical skills (AS-NTS) rating tool, einer validierten Taxonomie, speziell entwickelt, um die psychosozialen Fertigkeiten von vorklinischen Medizinstudenten zu bewerten, ermittelt.

Ergebnisse: Die situative Motivation der Studierenden korrelierte schwach mit den gemessenen psychosozialen Fertigkeiten im notfallmedizinischen Simulationstraining.

Conclusion: Obwohl Motivation als ein wichtiger Faktor zur Leistungsverbesserung in verschiedenen Gebieten und insbesondere in der Medizin gilt, zeigte unsere Studie keinen Zusammenhang zwischen situativer Motivation und der Ausprägung von psychosozialen Fertigkeiten in Notfallsimulationstrainings.

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8 Supplementary Material

8.1 Adapted (German) Situational Motivation Scale (SIMS)

Fragebogen (SIMS)
Lesen Sie jede Aussage aufmerksam durch.
Kreuzen Sie jeweils die Nummer an, die am besten beschreibt, warum Sie Medizin studieren.

	Trifft überhaupt nicht zu	Trifft fast nicht zu	Trifft ein wenig zu	Trifft teilweise zu	Trifft eher zu	Trifft weitgehend zu	Trifft vollkommen zu
1. Weil ich denke, dass diese Tätigkeit interessant ist.	①	②	③	④	⑤	⑥	⑦
2. Weil ich es für mich selbst mache.	①	②	③	④	⑤	⑥	⑦
3. Weil ich es tun soll.	①	②	③	④	⑤	⑥	⑦
4. Es mag gute Gründe geben das hier zu tun, aber ich persönlich sehe keine.	①	②	③	④	⑤	⑥	⑦
5. Weil ich mich schlecht fühlen würde, wenn ich es nicht täte.	①	②	③	④	⑤	⑥	⑦
6. Weil ich denke, dass diese Tätigkeit angenehm ist.	①	②	③	④	⑤	⑥	⑦
7. Weil ich denke, dass diese Tätigkeit gut für mich ist.	①	②	③	④	⑤	⑥	⑦
8. Weil es etwas ist, das ich tun muss.	①	②	③	④	⑤	⑥	⑦
9. Ich tue es, aber ich bin nicht sicher, ob es das wert ist.	①	②	③	④	⑤	⑥	⑦
10. Weil ich bei dieser Sache erfolgreich sein möchte, sonst würde ich mich sehr schämen.	①	②	③	④	⑤	⑥	⑦
11. Weil diese Tätigkeit Spaß macht.	①	②	③	④	⑤	⑥	⑦
12. Weil ich das so entschieden habe.	①	②	③	④	⑤	⑥	⑦
13. Weil ich keine andere Wahl habe.	①	②	③	④	⑤	⑥	⑦
14. Ich weiß nicht; ich sehe nicht, was mir diese Tätigkeit bringt.	①	②	③	④	⑤	⑥	⑦
15. Weil ich im Leben ein “Gewinner” sein möchte.	①	②	③	④	⑤	⑥	⑦
16. Weil ich mich bei dieser Tätigkeit gut fühle.	①	②	③	④	⑤	⑥	⑦
17. Weil ich glaube, dass diese Tätigkeit wichtig für mich ist.	①	②	③	④	⑤	⑥	⑦
18. Weil ich fühle, dass ich es tun muss.	①	②	③	④	⑤	⑥	⑦
19. Ich übe diese Tätigkeit aus, bin aber nicht sicher, ob es gut ist, ihr nachzugehen.	①	②	③	④	⑤	⑥	⑦
20. Weil ich bei dieser Sache sehr gut sein möchte, sonst wäre ich sehr enttäuscht.	①	②	③	④	⑤	⑥	⑦

Supplement 1: Translated and adapted from Guay F, Vallerand R, Blanchard C (2000) *On the Assessment of Situational Intrinsic and Extrinsic Motivation: The Situational Motivation Scale (SIMS).* Motivation and Emotion. 24. 175-213.

8.2 Original English Version Situational Motivation Scale (SIMS)

Table I. Factor Loadings from The Exploratory Factor Analysis: Study 1

Items	Factors 1	2	3	4
Intrinsic motivation				
Because I think that this activity is interesting	0.91			
Because I think that this activity is pleasant	0.90			
Because this activity is fun	0.89			
Because I feel good when doing this activity	0.83			
Identified regulation				
Because I am doing it for my own good		0.77		
Because I think that this activity is good for me	0.31	0.60		
By personal decision		0.57		
Because I believe that this activity is important for me		0.52		
External regulation				
Because I am supposed to do it			0.85	
Because it is something that I have to do			0.75	
Because I don't have any choice			0.69	
Because I feel that I have to do it			0.58	
Amotivation				
There may be good reasons to do this activity, but personally I don't see any				0.83
I do this activity but I am not sure if it is worth it				0.74
I don't know; I don't see what this activity brings me				0.55
I do this activity, but I am not sure it is a good thing to pursue it				0.54
Eigenvalues	5.70	2.63	1.33	0.73
Explained variance	35.60	16.40	8.30	4.50

Supplement 2: Guay F, Vallerand R, Blanchard C (2000) *On the Assessment of Situational Intrinsic and Extrinsic Motivation: The Situational Motivation Scale (SIMS).* Motivation and Emotion. 24. 175-213.

8.3 Translated (German) Anaesthesiology Students' Non-Technical Skills Rating Tool (AS-NTS)

Aufgaben planen, priorisieren und durchführen			
	◯	sehr gut	gute Verhaltensbeispiele: • hält sich an den erlernten Wiederbelebungs-algorithmus • die erforderlichen Maßnahmen werden eingeleitet • priorisiert wichtige Aufgaben • strukturiert den Arbeitsablauf
	◯	gut	
	◯	durchschnittlich	
	◯	schlecht	schlechte Verhaltensbeispiele: • lässt sich von weniger wichtigen Aufgaben ablenken • …
	◯	sehr schlecht	

Zusammenarbeit mit dem Team: Informationen austauschen und das Team aktiv führen			
	◯	sehr gut	gute Verhaltensbeispiele: • gibt den Teammitgliedern klare Anweisungen und verteilt die verschiedenen Aufgaben • bringt das Team regelmäßig auf den neusten Stand • stellt sicher, dass die Teammitglieder ein gemeinsames Verständnis vom Problem entwickeln • sagt den Teammitglieder, was sie/er von ihnen erwartet • übernimmt aktiv die Führung im Team
	◯	gut	
	◯	durchschnittlich	
	◯	schlecht	schlechte Verhaltensbeispiele: • bindet die Teammitglieder nicht ein • informiert das Team nicht, wenn vom bisher geplanten Handlungsablauf abgewichen werden muss • versichert sich nicht rück, dass die Teammitglieder ihre Aufgaben verstanden haben und diese erfüllen • verwirrt oder irritiert die Teammitglieder
	◯	sehr schlecht	

Teamorientierung			
	◯	sehr gut	gute Verhaltensbeispiele: • bindet die Teammitglieder in den diagnostischen Prozess mit ein • fragt die Teammitglieder aktiv nach benötigten Informationen • denkt laut über seine Vermutungen nach • sorgt für eine angenehme Atmosphäre im Team
	◯	gut	
	◯	durchschnittlich	
	◯	schlecht	schlechte Verhaltensbeispiele: • holt keine Meinungen der anderen Teammitglieder ein • berücksichtig deren Vorschläge nicht • wertet die Meinung eines Teammitglieds ab • kümmert sich nicht darum, dass man sich bei der Herz-Druck-Massage abwechselt
	◯	sehr schlecht	

Supplement 3: Moll-Khosrawi, P., Kamphausen, A., Hampe, W. *et al.* (2019) *Anaesthesiology students' Non-Technical skills: development and evaluation of a behavioural marker system for students (AS-NTS).* BMC Med Educ 19, 205.

8.4 Original English Version Anaesthesiology Students' Non-Technical Skills Rating Tool (AS-NTS)

Planning tasks, prioritising and problem solving		
○	Very good	Good behavioural examples: • Conducts the CPR algorithm • Takes (all) necessary steps • Prioritizes the tasks and structures workflow
○	Good	
○	Average	
○	Poor	Poor behavioural examples: • Is distracted by less important tasks
○	Very poor	
Teamwork and leadership		
○	Very good	Good behavioural examples: • Gives clear instructions to the team and allocates responsibilities • Updates the team about new insights • Ensures that the team develops the same understanding of the situation • Tells the team members what she/he expects from them to do • Leads the team
○	Good	
○	Average	
○	Poor	Poor behavioural examples: • Does not integrate the team into the process • Does not inform the team, if the planned plot has to be changed • Does not reinsure if the team members have understood their tasks • Confuses the team members
○	Very poor	
Team orientation		
○	Very good	Good behavioural examples: • Integrates the team members into the diagnostic process • Asks actively the team members which information they need • Thinks loudly about her/ his assumption (s) • Creates a good team athmosphere
○	Good	
○	Average	
○	Poor	Poor behavioural examples: • Does not aim to gather the opinion of the team members • Does not take the suggestions of the team into account • Devalues the opinion of other team members • Does not ensure that the team members alternate in performing the cardiopulmonary resuscitation (prevention of fatigue)
○	Very poor	

Supplement 4: Moll-Khosrawi, P., Kamphausen, A., Hampe, W. *et al.* (2019) *Anaesthesiology students' Non-Technical skills: development and evaluation of a behavioural marker system for students (AS-NTS)*. BMC Med Educ 19, 205.

9 Individual Contributions

I, Jonathan Steven Cronje, herewith state that I contributed in the following ways to the completion of the published article: “Correlation of Medical Students’ Situational Motivation and Performance of Non-Technical Skills During Simulation-Based Emergency Training”, that serves as the basis of this publication thesis:

1) Inclusion of candidates and processing of informed consent.
2) Acquisition and processing of data.
3) Literature research and critical appraisal.
4) Revising the manuscript critically for important intellectual content.
5) Final approval of the published version.

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To my youngest, Leonie. I miss you.

11 Curriculum Vitae

Entfällt aus datenschutzrechtlichen Gründen.

12 Eidesstattliche Versicherung (Affidavit)

Ich versichere ausdrücklich, dass ich die Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die von mir angegebenen Quellen und Hilfsmittel nicht benutzt und die aus den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen einzeln nach Ausgabe (Auflage und Jahr des Erscheinens), Band und Seite des benutzten Werkes kenntlich gemacht habe.

Ferner versichere ich, dass ich die Dissertation bisher nicht einem Fachvertreter an einer anderen Hochschule zur Überprüfung vorgelegt oder mich anderweitig um Zulassung zur Promotion beworben habe.

Ich erkläre mich einverstanden, dass meine Dissertation vom Dekanat der Medizinischen Fakultät mit einer gängigen Software zur Erkennung von Plagiaten überprüft werden kann.

Unterschrift: .....