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ORIGINAL ARTICLE

Resilience, sense of self-efficacy, and risk-taking in the context of task performance during ship simulator training

Andrzej Piotrowski [1 · A,C,D,E,F], *Ewa Sygit-Kowalkowska* [2 · A,D,E,F], *Iwona Królikowska* [3 · B,D,E,F], *Agnieszka Suchocka* [3 · B,D,E,F]

1: Institute of Psychology, University of Gdansk, Gdansk, Poland
2: Kazimierz Wielki University, Bydgoszcz, Poland
3: Polish Naval Academy of the Heroes of Westerplatte, Gdynia, Poland

BACKGROUND
Educating sailors requires intensive training, which involves highly specialized ship simulators. This is due to the crew's responsibility for the safety of the people on board and the simultaneous risk of making improper decisions under time pressure and with insufficient data. Thus far, empirical data on the role of personal psychological resources in the process of sailor skills training have been lacking.

PARTICIPANTS AND PROCEDURE
Fifty cadets of the Navigation and Naval Weapons Faculty and 51 cadets of the Mechanical and Electrical Engineering Faculty of the Polish Naval Academy in Gdynia, Poland, participated in the study. Task performance during ship simulator training was assessed. Additionally, the participants completed the General Self-Efficacy Scale, the Brief Resilience Scale, the Questionnaire of Stimulating and Instrumental Risk, and the Status-Driven Risk Taking Scale.

RESULTS
Three subgroups were distinguished based on their levels of task performance and the psychological variables measured. Cadets who achieved the highest task performance during simulator training simultaneously reported the highest sense of self-efficacy and resilience, average acceptance of instrumental risk, status-driven risk and its subdimensions, as well as the highest acceptance of stimulating risk.

CONCLUSIONS
Individual differences such as resilience, sense of self-efficacy, and risk acceptance have a different configuration among individuals who achieved the highest task performance on ship simulators. Identifying individuals with the optimal configuration of these variables may be useful for designing education and development processes for officers, although this requires further studies.

KEY WORDS
risk; simulator; resilience; self-efficacy; ship

CORRESPONDING AUTHOR – Andrzej Piotrowski, Ph.D., Institute of Psychology, University of Gdansk, 4 Bażyńskiego Str., 80-952 Gdansk, Poland, e-mail: andrzej.piotrowski@ug.edu.pl

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BACKGROUND

Despite significant advances in international sailing in the last 20 years, an average of 17 thousand maritime accidents occur each year, with the human factor being responsible for between 60-80 and 90% of them (Reason, 2017). Maritime accidents involve not only significant loss of life, but also loss of cargo and infrastructure. They also pose significant risks for the environment.

Ship crews work in a potentially stress-provoking environment. The stressors involve working during the night due to shift work and overtime (Oldenburg & Jensen, 2019). At the same time, fatigue, stress, excessive risk-taking, mistakes, routine, excessive trust in the automation of the navigation process, and lack of teamwork skills are the most frequent crew-related causes of accidents (Akyuz, 2015). An analysis of 177 maritime accident reports concluded that human errors have most frequently occurred due to a lack of situational awareness (Grech et al., 2002). This is related to the lack of ability to anticipate future behaviors, inappropriate perception of information, and inappropriate integration of available data. Thus, effective education of ship crews remains important (Kojs & Urban-Kojs, 2010).

Naval accidents have very negative physical and mental consequences for the involved parties. They also cause significant ecological risks and material losses. Nevertheless, they remain an understudied phenomenon. The paucity of psychological studies and their relative lack of depth point to a lack of appropriate explanation. Using ship simulators is more effective with individuals who already possess a solid foundation of navigation skills (Overskeid, 1990). The study by Wulvik et al. (2020) showed that different simulated scenarios result in significant differences in the participants' experienced physical and mental strain. Also, according to Orlandi and Brooks (2018), the physical demands of simulator training largely depend on the amount of time spent on difficult tasks.

As indicated above, risk-taking is a voluntary behavior which may significantly impact the likelihood of occurrence of undesirable events involving ships. Simultaneously, the ability to effectively cope with risk is an empirically proven stress coping resource (European Agency for Safety and Health at Work, 2012). Individual risk-taking is a multidimensional concept which can be analyzed from several perspectives (Geier & Luna, 2009). Zaleśkiewicz (2001) differentiated two types of risk: instrumental and stimulating. Stimulating risk occurs when individuals take risks in order to provide themselves higher stimulation (Zaleśkiewicz & Piskorz, 2004). The aim of stimulating risk-taking is the desire to provide positive emotional experiences, and it is dominated by emotional processes. Instrumental risk is taken to achieve a given goal and it involves the consideration of potential gains and losses (Zaleśkiewicz & Piskorz, 2007). Simultaneously stimulating and risky behaviors are also possible, for example, gambling (Vong, 2007). Ashton et al. (2010) point to the motivation for status-driven risk. This motivation leads to a drive for social status and material wealth even in situations of physical threat. In this concept, status is defined as high earnings, a prestigious job, or a high position in the social hierarchy. The job of a soldier involves numerous risky situations (Piotrowski et al., 2020) and is considered to be prestigious due to the culture of honor, courage and sacrifice attributed to the idea of this organization.

Studies on psychological aspects of ship safety and navigation typically focus on the personality type (Skuzińska et al., 2020). They indicate that personality and individual differences may be useful for selecting and promoting ship crew members (Wijk & Water, 2000). Studies have shown a positive relationship of neuroticism, and a negative relationship of conscientiousness, with the number of mistakes made on ship simulators by cadets of the Royal Norwegian Navy (Saus et al., 2012). The cumulative effect of extraversion, neuroticism, and conscientiousness shapes the results on ship simulator mistakes, and individuals low in neuroticism and high in extraversion and conscientiousness have been identified as having the resilient personality type (Berry et al., 2007).

Scientific analyses frequently underscore the fact that coping with stressful situations is possible due to personal resources, which may include self-efficacy (Lipińska-Grobelny & Zwardoń-Kuchciak, 2023) and resilience (Pastwa-Wojciechowska et al., 2021).

Thus far, self-efficacy and resilience have been studied in organizational psychology as psychological constructs that are related to the person-organization fit in a sample of university graduates (Wongsuwan & Na-Nan, 2022). Self-efficacy influences the fulfilment of job roles, including goal-oriented behaviors and personal beliefs in one's motivation and resources to engage in them (Priyaadarshini & Lalatendu, 2024). In turn, resilience impacts the personal reception of stress, allowing for effective coping (Hartmann et al., 2020).

Psychological studies on the effectiveness of task performance on ship simulators is currently not a standard in sailor education. To the best of our knowledge, thus far, studies on the level of task performance on ship simulators in the context of resilience, sense of self-efficacy, and risk-taking have not been carried out. The main aim of this study was to determine the psychological profiles of ship mechanics and navigators in terms of resilience, sense of self-efficacy, and risk-taking in the context of task performance ratings on ship simulators. This led to formulating the following research question: What

are the resilience, sense of self-efficacy, and risk-taking levels among mechanics and navigators who differ in terms of their ship simulator task performance?

The following hypotheses were put forward:

H1. There are differences in resilience, sense of self-efficacy, and risk-taking between the studied groups.

H2. Psychological variables (resilience, sense of self-efficacy, and risk-taking) influence the shaping of task performance on ship simulators.

PARTICIPANTS AND PROCEDURE

PARTICIPANTS

A total of 101 individuals (50 students of navigation, including 9 women, and 51 students of mechanical engineering, including 10 women) from the Naval Academy participated in the study. The participants were aged between 19 and 29 years, with a mean age of 22.41 (*SD* = 2.41).

PROCEDURE

The study was carried out during ship simulator exercises. Mechanical engineering students were training on the MED3D engine room simulator, which presented a 3D model of a ship's engine room based on real life. Navigation students were training on individual Virtual Bridges and on the Main Bridge in a navigational-maneuver simulator based on the Navi Trainer Professional 5000 software. The simulator software allows for the use of nine training locations, which include ports of various level of detail, as well as 12 types of ships, with the option of modifying their parameters. Training on simulators of this type provides the possibility to acquire technical, procedural, and operational skills without the risks and costs related to training on the job. During such training, simulations are computer generated (Renganayagalu et al., 2019). They allow trainees to make mistakes and learn from them in an environment free of real, physical consequences.

Then, the participants individually filled out a set of questionnaires which were collected by the training instructor, who also added the students' task performance ratings.

MEASURES

Self-efficacy. Self-efficacy was measured using the General Self-Efficacy Scale (Juczyński, 2012). The scale consists of 10 items, e.g., "If I am in trouble, I can usually think of a solution." The participants give their answers on a 4-point Likert-type scale, from 1 (*not at all true*) to 4 (*exactly true*). The scale's reliability, measured with Cronbach's α coefficient, was .83 in the current study.

Resilience. Resilience was measured with the Brief Resilience Scale by Konaszewski et al. (2020). The scale consists of 6 items, e.g., "It does not take me long to recover from a stressful event." The participants rate each item on a 5-point Likert-type scale, from 1 (*strongly disagree*) to 5 (*strongly agree*). The scale's Cronbach's α reliability was .71 in the current study.

Status-driven risk taking. The Status-Driven Risk Taking Scale (Ashton et al., 2010), based on the work of Atłas (2022) may have two subscales: risking health and life for status (8 items, "I would enjoy being a famous and powerful person, even if it meant a high risk of assassination") and acceptance of risk in striving for prestige and wealth (6 items, e.g. "I would rather live as an average person in a safe place than live as a rich and powerful person in a dangerous place"). The participants rate each item on a 5-point Likert-type scale, from 1 (*disagree fully*) to 5 (*agree fully*). Cronbach's α reliability for risking health and life for status was .77, while for acceptance of risk in striving for prestige and wealth, it was .82.

Stimulating and instrumental risk. Propensity for stimulating and instrumental risk-taking was measured with the Questionnaire of Stimulating and Instrumental Risk (Makarowski, 2012). The questionnaire is comprised of two subscales measuring stimulating risk (4 items, e.g. "When I have to take a risk, I carefully consider the possibility of failure") and instrumental risk (3 items, e.g., "I take risks only when they are necessary for achieving my goals"). The participants rate each item on a 5-point Likert-type scale, from 1 (*true*) to 5 (*false*). Cronbach's α reliability for stimulating risk was .84, and for instrumental risk, it was .86.

Task performance level on the ship simulator. To assess task performance on the ship simulator, the training instructor was asked to rate how well each cadet has performed their task on a 1-10 scale (1 – *very poorly*, 10 – *very well*). The higher the assessment, the fewer mistakes the cadet made when performing their task on the simulator.

STUDY PROCEDURE

The study was carried out directly after an exam assessing ship control abilities on a simulator. Each participant independently carried out a task on the simulator and then filled out a set of questionnaires. The examiner rated each participant's task performance on a scale of 1 to 10 on the last page of the questionnaire set. The higher the rating, the better the task performance. Due to the difference in their scope of responsibilities, the mechanics and navigators completed different tasks on the simulator.

DATA ANALYSIS

The IBM SPSS 27 software was used for statistical analyses, which included comparing means, correlation analysis, and k-means clustering.

RESULTS

Before examining whether it is possible to distinguish participant clusters based on their task performance on the simulator as well as select psychological variables, we evaluated whether the navigators and the mechanics differed from one another with respect to the studied variables. No statistically significant differences on the psychological variables were found. However, the navigators received higher assessments of task performance (M = 7.38) compared to the mechanics (M = 6.67), with borderline statistical significance (p = .056).

Next, the correlation analysis showed that only resilience was positively correlated with task performance assessments, although at a low level (r = .24). Finally, k-means cluster analyses for 2, 3, 4, and 5 centroids were carried out. The results are shown in Table 1.

The k-means cluster analysis showed that the model with three centroids was the most effective. The group which achieved the highest task performance assessments (Cluster 3) was characterized with the highest sense of self-efficacy, the highest resilience, the highest acceptance of stimulating risk, the lowest acceptance of instrumental risk, and an average level of both overall status-driven risk as well as its subdimensions.

The cut-off measure of −7 points results from the cluster analysis conducted, which distinguished three groups according to the results, where the score of 7 characterized two groups and the score of 8 characterized the group with the best results. Participants who achieved a score of 7 on task performance assessments were not a homogeneous group. It contained both individuals who reported having virtually the same levels of the sense of self-efficacy as cadets from Cluster 3 (Cluster 2) and individuals with a much lower sense of self-efficacy (Cluster 1). Resilience was lower in Clusters 1 and 2 than in Cluster 3, with the greatest difference occurring between Clusters 1 and 3.

DISCUSSION

Thus far, studies on the above-mentioned psychological variables in the context of ship simulator task performance assessments have not been carried out. The only available study is the one by Renganayagalu et al. (2019), in which students training on more advanced ship simulators (i.e., using virtual reality) reported having a higher sense of self-esteem than did students who only trained on desktop simulators. However, this was based on student self-reports, without using the instructors' ratings of the students' performance.

The aim of our study was to identify the profiles of individual differences such as resilience, sense of self-efficacy, and risk-taking in navigators and mechanics differing in terms of task performance on ship simulators. The difference between good and excellent task performance may be decisive for many aspects of the mechanics' and navigators' functioning on ships. First, future senior officers are recruited from among the best-performing students, which translates into both status as well as future career, as they

Table 1

Means, standard deviations and results of the k-means cluster analysis on the current sample (N = 101)

Variable	*M*	*SD*	Cluster			*F*	*p*
			1 *n* = 36	2 *n* = 38	3 *n* = 27		
Task performance assessment	7.02	1.88	7	7	8	2.26	.109
Self-efficacy	32.44	3.75	29.94	33.08	34.89	19.50	< .001
Resilience	23.35	4.16	20.75	23.55	26.52	20.74	< .001
Stimulating risk	12.01	4.06	13.14	9.74	13.70	11.78	< .001
Instrumental risk	6.36	2.52	6.50	7.32	4.81	9.14	< .001
Risking health and life for status	23.43	2.92	22.08	24.79	23.33	9.25	< .001
Acceptance of risk in striving for prestige and wealth	17.28	4.91	13.78	22.08	15.19	71.83	< .001
Status driven risk	40.71	6.14	35.86	46.87	38.52	87.65	< .001

will assume leadership positions in the future. Individuals who perform their tasks only adequately may only become second or first officers, will rarely have access to leadership positions. Second, the best students have more opportunities of selecting their job placement, which influences both status and wealth. Third, the careers of the best navigators and mechanics are more dynamic from the outset, allowing them to achieve higher positions faster.

The difference between excellent (ratings of 8) and good (ratings of 7) task performance on ship simulators was not great in our study, although it can be decisive for future leadership placement. Those navigators and mechanics who achieved the highest ship simulator task performance assessments differed in terms of the analyzed variables from those cadets who achieved lower task performance. They were characterized by the highest levels of the sense of self-efficacy and resilience. Studies show that these variables may be good predictors of student achievements (Avci, 2022), future professional career (Schultheiss et al., 2023), and even quality of life of individuals working during retirement (Jurek & Niewiadomska, 2021). These resources allow for effective coping in difficult situations and perseverance in goal-oriented activity (Campbell-Sills & Stein, 2007). Resilience and the sense of self-efficacy are factors of proven importance in uniformed services: for achieving professional success in the navy or coping with stress in the army (Guillén, 2021).

The small difference in the simulator task ratings by the examiner may have resulted from several causes. First, only those individuals who have completed the course and achieved a sufficient skill level could participate in the exam. Next, the examiner already familiarized themselves with the participants' skill levels during the course and admitted only those who became proficient in simulator tasks for the exam. Another cause may have been the examiner's tendency to rate participants in a similar way, not using the full spectrum of potential ratings (Goddard et al., 2011). Moreover, using a single, general index of the examiner's rating may have not been sufficiently detailed. Using an automated, complex system of participant performance rating (e.g., reaction time, optimal decision-making, number of errors that required correction) could eliminate some of these limitations and lead to a greater variance in the performance ratings. Finally, other variables not measured in the current study, for example, executive functions, could be related to task performance.

Cadets receiving the highest assessments of ship simulator task performance simultaneously reported average levels of risk acceptance in almost all subdimensions except stimulating risk. Stimulating risk-taking is related to the motivation to participate in more highly stimulating activities (Zaleśkiewicz & Piskorz, 2004), meaning impulsive behaviors aimed at achieving a state of excitement, with low self-control. In turn, instrumental risk-taking is related to reflecting on future gains. Thus, it is assumed to be dominated by cognitive processes, with high self-control. However, this variable may have been shaped according to the context of the study (the learner is rated by the instructor according to their task performance). According to the literature, both instrumental and stimulating risk-taking are possible in the same area of life, although they are situation-dependent (Makarowski, 2012).

The opportunity to command a military vessel or serve as the first mechanic can be considered one such activity. The highest-performing cadets reported average levels of instrumental risk, similarly to status-driven risk and its subdimensions. Calculating the risks taken may decide on the success of a naval operation. Status-driven risk-taking may explain the likelihood of being involved in accidents (Ashton et al., 2010). Excessive risk-taking contributes to maritime accidents such as maneuvering errors (Hejmlich, 2022), collisions, and damage to the ship (O'Connor et al., 2007). On the other hand, avoiding all risk is related to lower chances of career development (Al Issa, 2021).

CONCLUSIONS

Serving on a ship is related to numerous physical, cognitive, and emotional challenges. Mistakes made by navigators or mechanics may threaten the life and health of the crew, damage to the ship, or ecological catastrophe. Serving on a ship is considered to be a risky profession, and personal resources such as resilience and the sense of self-esteem are useful in coping with difficulties. Our results show that cadets achieving the highest assessments of ship simulator task performance are characterized by the highest levels of the sense of self-esteem and resilience, as well as average levels of acceptance of instrumental risk and status-driven risk and its subdimensions, and the highest levels of acceptance of stimulating risk. Thus, simulations may be used to evaluate students' (individual and group) educational achievements, which may serve as useful feedback when designing soldiers' future educational and professional paths. Our study shows that, at the same training duration, some psychological variables may differentiate the performance of tasks carried out by ship navigators and mechanics. Thus, further studies are necessary to establish an evidence base for recruitment decisions, which may translate into higher performance, and thus, greater personal, material, and environmental safety. The practical effect of our results is the fact that programs that develop personal resources, such as resilience, sense of self-efficacy, and risk management, can improve cadets' fitness for future duty. The integration of psychological profiles with educa-

tional attainment can help better manage crews' human resources. Our results may contribute to filling the knowledge gap in the current understanding of the human error in maritime accidents, which could be included in educational and training programs for naval cadets, sailors, and other personnel.

LIMITATIONS

The current study has a range of limitations. First, the study was carried out during a practical exam, the results of which were used to assess the students' level of skill achievement and future professional position. This may have facilitated the tendency towards exaggerate self-presentation. Second, the students' assessments were given by only one person, which may have led to biased ratings. Third, the exam situation may be related to additional stress for some individuals, which may have impacted their questionnaire answers. Fourth, many simulator training programs focus on routine situations rather than exceptions or critical incidents. As a result, the resources of resilience, sense of self-efficacy, and risk-taking may not have been fully activated. Fifth, and finally, other variables which were not included in the current study (e.g., level of experience, differences in task difficulty) may have impacted the level of simulator task performance.

The measure used to assess risk is not the only one available in scientific publications. Various methods have been used thus far to study the relationships of risk-taking with health behaviors, emotional problems, and work in selected professions. At present, it is difficult to assess the usefulness of other, more complex measures which include other areas of life, without work, but with social relationships (Weber et al., 2002), which are based on descriptions related to conformism (Knight et al., 1994), or which focus on risk-taking in the moment (Lejuaez et al., 2002). This would require empirical testing.

ETHICS

The research was conducted in accordance with the recommendations of the Declaration of Helsinki and approved by the Ethics Committee of the Polish Naval Academy of the Heroes of Westerplatte, Gdynia, Poland (ID: 3/2023).

INFORMED CONSENT STATEMENT

Informed consent was obtained from all participants involved in the study.

Supplementary materials are available on the journal's website.

Disclosures

This research received no external funding.
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The authors declare no conflict of interest.

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