Understanding Performance Changes of Operators of the Dutch Special Forces

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“A thesis is an aptitude test for students. The approval of the thesis is proof that the student has sufficient research and reporting skills to graduate, but does not guarantee the quality of the research and the results of the research as such, and the thesis is therefore not necessarily suitable to be used as an academic source to refer to. If you would like to know more about the research discussed in this thesis and any publications based on it, to which you could refer, please contact the supervisor mentioned.”

Abstract

The purpose of this study was to gain a better understanding of what factors influence the performance of operators in the Dutch Special Forces. For this purpose, operators filled in a bi-weekly questionnaire on a tablet during their advanced training program. Forty-three operators took part, of whom six completed the questionnaires consistently throughout the program. These operators self-reported their performance and multiple variables related to their physical and psychological wellbeing. The data was analyzed on an individual level and correlation network diagrams were made. We found that even during a tough training course, operators generally indicated that they were able to perform relatively well. Variables correlating to performance differed vastly between the operators. These findings show the need for an individual approach to understand changes in performance. Suggesting that group-based interventions to increase performance might fall short of stimulating maximum performance in individual operators. This has gained recent attention for athletes, but so far not for special forces operators. To achieve maximum performance individual differences between operators need to be understood. Future research may examine a procedure for research and practice to address the person-specific performance changes.

Keywords: stress, recovery, personalized approach, correlation graphs, military

PREFACE

This thesis contains the final assignment needed to complete the master ‘Talent development & creativity’ from the University of Groningen. This assignment was part of a larger collaborator between the university of Groningen and the Korps Commando Troepen (Dutch special forces). It was a pleasure to work with experts of both organizations and it made me respect the special forces operators even more. This assignment consisted of writing a master thesis and multiple practical assignments. A report and reflected of these practical assignments can be found in the Appendix. I would like to thank Dr. Ruud den Hartigh for the excellent guidance he provided.

Understanding Performance Changes of Operators of the Dutch Special Forces

The special forces division of militaries represent the most elite operators (special forces soldiers) and is the most demanding division of all military specialties. Special forces are becoming increasingly important for modern militaries (Bartone et al., 2008). They are expected to possess the physical and cognitive skills to be able to perform in stressful and unexpected scenarios (Hoffman et al., 2016). These special forces operators are routinely expected to perform at higher levels than civilians and regular tactical personnel (i.e. general soldiers, police officers) (Ricciardi et al., 2007). Hence, understanding what influences the performance of operators and how to use these insights to improve their performance is especially important for Special Forces. With our research we will attempt to fill two gaps in the existing literature in this field.

Firstly, the existing literature on the performance of these operators has mostly focused on how a single influencing variable impacts performance (e.g. Hansen et al., 2018; Lendal & Kjaer, 2021; Tharion et al., 2005; Williams et al., 2014). This is presumably done to isolate the effects of the influencing variables that are measured. While this method is scientifically sound, the information gained from this does not reflect the real-world conditions that operators face (Grandou et al., 2019; McFarland, 2011; O'Leary et al., 2020). In real-world conditions variables influence each other, for instance, high stress causes worse sleep quality, thereby negatively influencing performance, and so forth (Grandou et al., 2019; McFarland, 2011). As another example, recently Velde et al. (2020) showed that straight after a high intensity speed march, operators were worse at memorization they were before the exercise. Thus, showing the complexity of the variables where they might influence each other, where for example physical variables can affect mental performance. Therefore, we argue that there is a need to focus on how a broader spectrum of variables influences performance. To our knowledge, the military literature field typically does not use such an

approach.

Secondly, there has been a recent shift in the sports literature. This shift might also be relevant to the military context since both operators and athletes need to able to perform well, both physically and mentally. A lot of literature in the sports field (and the military field) uses a group analysis approach, where groups of athletes are analyzed to see what impacts their performance (e.g. Dupont et al., 2010; Brink et al., 2010). But, using group level analysis to guide individuals within sports has recently been getting criticism (Den Hartigh et al., 2018; Hamaker et al., 2005; Molenaar, 2004; Molenaar & Campbell, 2009; Neumann et al., 2021; Van Geert, 2014). This criticism mainly revolves around the idea that group level analysis have low generalizability to individual models (Fisher et al. 2018). Neumann et al. (2021) argue that the literature field can tend to overestimate the generalizability of conclusion made bases on group or individual analysis. Insights gained from group level analysis only permit 'in general' or 'on average' statements according to Glazier & Mehdizadeh (2019). Using, for example, training programs bases on group level analysis may thus be suboptimal for individual athletes (Neumann et al., 2021), and training programs should primarily rely on individual analysis (Orie et al., 2020). So far, the military literature about performance still overwhelmingly uses a group-based approach (e.g Conkright et al., 2020; Friedl, 2018; Lendal & Kjaer, 2021; Pawiński & Chami, 2019). Thus, there is a gap in military literature where the sports literature, which is in some aspects a similar field, suggests that this group-based approach might be outdated.

However, while the military and sport athletes both may aim for optimal performance, they do so in different contexts. Operators are commonly exposed to scenarios where optimal performance is difficult. They often endure periods of prolonged wakefulness or irregular sleeping patterns and experience sustained physical and cognitive stressors during training or on the battlefield (Williams et al., 2014). As another example, operators suffer more injuries

where 50% of operators have one sport-related injury per year, which is substantially higher than sports injuries in athletes (Lendal & Kjaer, 2021). Despite this, a small amount of research has shown that overall, results from sports and military research generalize quite well to each other (Martin et al., 2012; Sell et al., 2019; Ward et al., 2008). Thus, we suspect that the effectiveness of using an individualized approach for athletes will also be true for operators, but to our knowledge, this has not been tested yet.

In this research we will attempt to fill these two gaps in literature (looking at the combined impacts of variables on performance and the individual approach to performance) by examining the individual performance of operators over time. Examining multiple factors that may relate to their performance and whether a group-based or individual-bases approach should be used. In doing so, we will focus on the following key variables: stress, recovery, sleep and mental influences which we will further discuss below.

Stress

For decades, the impact of stress on performance has been a topic of high interest, especially in a sports setting (Butler & Hardy, 1992). Fletcher et al. (2006) define stress as: "an ongoing process that involves individuals transacting with their environments, making appraisals of the situations they find themselves in, and endeavoring to cope with any issues that may arise" (p. 329). This can be both physiological stress like strenuous workouts and psychological stress such as being scared. Both have the possibility to negatively influence performance for athletes (Dupont et al., 2010; Fletcher et al., 2006; Ispirlidis et al., 2008; Kavanagh, 2005).

However, stress does not necessarily have a negative effect on performance. Kavanagh (2005), for instance, argues that stress has an inverted-U shape relation with performance. He suggests that low levels of stress will lead to low performance and high levels of stress will lead to low performance. When moderate levels of stress are present,

performance is likely to be higher due to stimulation that keeps an individual alert and vigilant. However, even if moderate stress might have a positive impact, extended exposure can lead to a negative impact on performance (Kavanagh, 2005). This suggests that the absence of stress and high levels of stress negatively influence performance and long-term stress tends to negatively influence performance. Thus, for operators to perform well, differential impacts of stress should be kept in mind.

Individuals can differ largely in their response to stressors (Pearson & Thackray, 1970). For example, people classified as “high anxiety” tend to experience more strain as a result of a stressor than people who are classified as “low anxiety”. Hill et al. (2021) recently argued that when looking at the resilience of athletes (the ability to adapt to stressful events), an individual analysis level should be used to avoid wrong conclusions about the individual. In the military context is has been shown that multiple characteristics moderate the amount of strain felt from a stressor. These include: low military rank, minority group membership, and poorer socioeconomic status (Kavanagh, 2005). Showing the complex nature the influence of stress has on performance, where stress could be detrimental or beneficial, and may impact different individuals differently.

Recovery

When high stress is unavoidable and it impacts performance negatively, recovery is needed. The effects of recovery of performance are well researched (e.g. Brink et al., 2010; Budgett, 1998; Steenland & Deddens, 1997; Schmikli et al., 2011; Vaile et al., 2010). However, many recovery strategies used by elite athletes are ad hoc in nature with little evidence on the outcomes and mechanisms (Montgomery et al., 2008). Showing discrepancies between research and practice. This might be related to findings by Hecksteden et al. (2017) and Kellmann et al. (2018). They argue that there is a need to approach recovery from an individual viewpoint, where recovery strategies that work for one athlete might not

work for the other. Vaile et al. (2010) mention in their research: “Recovery from training and competition is complex and involves numerous factors and is typically dependent on the nature of the exercise performed and any other outside stressors that the athlete may be exposed to” (p. 5). Thus, the difference between science and practice might be related to the difference need individual athletes have.

Recovery for the military might be even more complex than for athletes. Most of the findings mentioned above come from research done on athletes. Athletes often focus a lot of attention on recovery where in a military context there are periods with less attention for recovery. Operators are often exposed to periods of sub-optimal recovery with periods of caloric deficit, lack of sleep, and high-energy expenditure when training or partaking in operations (Kyröläinen et al., 2008; Tharion et al., 2005). Operators often undergo the rigors of training in such a manner that does not allow optimal recovery and performance (Conkright et al., 2020). For example Conkright et al. (2020) found that operators that had a multiple week long training did not fully recover until six weeks after the training. Within the military context, operators will often get the minimal amount of recovery they need, which does not allow optimal performance but adequate performance. A better understanding of the impact on recovery on performance might make more efficient recovery strategies possible, which are tailor for the individual operator.

Sleep

One of the main factors that aid a good recovery is sleep. The effects of not getting enough quality sleep (sleep loss) on performance have been well documented in the scientific literature (e.g., Anderson et al., 2015; Daley et al., 2009; Drummond et al., 2012). It can be detrimental to both psychical and mental performance (Drummond et al., 2012; Zhang & Liu, 2008)

According to (Luxton et al. (2011) the effects of sleep loss are particularly worrisome

for the military since operators are often subject to situations where they endure prolonged periods of inconsistent or suboptimal sleep. Anderson et al. (2016) report that sleep deficiencies is to blame for a substantial amount of accident and potentially dangerous situations in the military. In the military sector bad performance can have more severe consequences than in the civilian sector, thus highlighting the need of good sleep for operators (Hansen et al., 2018).

Within the military the quality of self-reported data about sleep is low and there is a lack of control for confounding variables such as physical activity and motivation in the majority of sleep studies (Grandou et al., 2019). Most operators deny sleep problems but a sizeable minority even meet the criteria for clinal insomnia (Hansen et al., 2018). Collectively, it has been known for a long time that military performance deteriorates under sleep loss conditions (Haslam, 1984; Knapik et al., 1990; Rognum et al., 1986). However, most of these studies have been conducted on group level. Although we know that different people have different sleep needs. There is ample research on how individuals differ in how much sleep they need to function well (Ferrara & De Gennaro, 2001; Mercer et al., 1998; Petrov & Lichstein, 2016). Thus, operators need ample sleep to be able to perform maximally, but the amount of sleep they need will differ from person to person. To maximize the performance of an individual operator we need to understand how operators can differ in how sleep impacts their performance.

Mental influences

In their research Laborde et al. (2012) argue that emotions are an important parameter to take into account in every domain where someone is trying to reach optimal performance. In the military context, there is a need to keep alert and sharp under pressure. Operators that are better able to regulate their emotions proved to be able to perform better when under pressure (Morgan et al., 2007). This is supported by Hatzigeorgiadis et al. (2011) who found

that operators that had a more positive emotional state even performed better in physical tasks. Lazarus (2000). The papers mentioned here looked at how at group level emotions may impact performance. Woodman et al. (2009) showed in their paper that individuals can have large differences in how their emotions influence their sports performance. This is supported by Hanin (2000) where it was found that individual performers can differ in emotional states when achieving optimal performance. For example, one performer might performer best when tense and angry, where another performer might not be able to perform well whilst tense and angry. Thus, to understand what is needed to maximize the individual's performance of operators there is a need to adopt an individual approach since there can be large individual differences.

Present research

Within the military literature most research investigating what influences performance have been done while investigating a singular variable, while different variables might influence each other. In addition, there has been growing attention for the individual differences in variables that impact performance within the sports literature. This growing attention has not reached the scientific military literature yet.

In this research we will attempt to fill the gaps in the literature by investigating what factors relate to performance for operators. For this, we will follow multiple operators of the KCT during their advanced training program: the 'assaulter course'. The KCT is the special forces unit of the Royal Netherlands Army. We will use self-reported data about influential factors and self-reported data about the performance of the operators. These factors are: physical recovery, mental recovery, physical performance capability, mental performance capability, emotional balance, overall recovery, muscular stress, lack of activation, negative emotional state, overall stress, group atmosphere, self-efficacy, sleep quality, perceived physical exertion, perceived mental exertion, and pressure to perform. Since there is little

existing literature on how these combined variables impact the performance of these special forces operators, we will answer our research questions with a bottom-up approach. That is: 'What factors relate to performance of individual operators during the assaulter course of the Dutch Commando Corps?'

Method

Participants

For this study 43 individuals were followed, who were involved in the assaulter course of the special forces training program. Most of the participants are active military personnel. The participants can therefore be regarded as highly fit and capable. Due to the sensitivity of information regarding military personnel, no personal information was collected. During the training phase we followed, the operators were asked to fill in questionnaires on a voluntary basis.

Procedure

This study took place as part of a larger collaboration between the KCT and the University of Groningen (RUG). We followed the participants during their 'assaulter course'. This is an eight weeklong course that is both physically and mentally demanding. The assaulter course happens relatively early in the career of the operators. The operators that were taking part in the training at that time, were asked to voluntarily fill in a bi-weekly questionnaire. Part one was filled in at the start of the week (Monday) and part two at the end of the week (Friday). They could fill in both questionnaires online. In addition to this, the operators were provided with a smart watch (Garmin Fenix 6). Data from these smart watches was originally planned to be used in the research. However, we ended up not using the data from the smart watches (see analysis). The data from the questionnaires was collected on an online platform where the data might be used for future projects. Of the 43 operators, the data of six were used in this paper (see analysis). Data was collected in a

secured manner so that we could not trace the data back to an individual

The assaulter course started in the middle of a week. Thus, for the first week there was no data for the Monday questionnaire. The course also ended in the middle of a week, thus for the last week there was no data for the Friday questionnaire. Of the total 8 weeklong course, this provided us with 6 weeks where both questionnaires were filled in on order that we could analyze.

Materials

As a part of the larger collaboration between the army and the university a questionnaire was made with variables deemed to be interesting by both parties. The questionnaire was not made with this study in mind, so for this study we selected the questions that were within the subject of this study. Variables consisted of one question per variable. The variables and questions are shown in table 1.

Table 1

Questionnaires used

Variable	Questions	Answer possibilities
Start of the week		
Physical recovery	How well are you physically recovered?	Ranging from 6 (very, very badly) to 20 (very, very well)
Mental recovery	How well are you mentally recovered?	Ranging from 6 (very, very badly) to 20 (very, very well)
Group atmosphere	How do you find the atmosphere in the group?	Ranging from 1 (very bad) to 100 (very good)
Optimism	How confident are you that you can perform at your maximum this week?	Ranging from 1 (very unsure) to 100 (very sure)
Sleep quality	How well have you slept in the past 3 nights?	Ranging from 1 (very bad) to 100 (very good)
	Below is a list of expressions that describe different aspects of the state of your recovery. Please indicate how you feel at this moment, compared to your best recovered state ever.	
Physical performance capability	Physical performance potential, for example: strong, physically fit, full of energy, energetic	Ranging from 0 (not applicable at all) to 6 (very applicable)
Mental performance capability	Mental performance potential, for example: alert, receptive, mentally sharp, focused.	Ranging from 0 (not applicable at all) to 6 (very applicable)
Emotional balance	Emotional balance, for example: satisfied, stable, in a good mood, everything under control.	Ranging from 0 (not applicable at all) to 6 (very applicable)
Overall recovery	Overall recovery, for example: recovered, rested, muscles relaxed, physically relaxed.	Ranging from 0 (not applicable at all) to 6 (very applicable)
	Below is a list of expressions that describe different aspects of the state of your stress. Please indicate how you feel at this moment, compared to your highest stressed state ever.	
Muscular stress	Stress on muscles, for example: exhausted muscles, tired muscles, muscle aches, stiff muscles.	Ranging from 0 (not applicable at all) to 6 (very applicable)
Lack of activation	Lack of activation, for example: unmotivated, lethargic, unenthusiastic, lack of energy.	Ranging from 0 (not applicable at all) to 6 (very applicable)
Negative emotional state	Negative emotional state, for example: depressed, stressed, irritated, touchy (short fuse).	Ranging from 0 (not applicable at all) to 6 (very applicable)
Overall stress	Overall stress, for example: tired, weary, overworked, physically exhausted.	Ranging from 0 (not applicable at all) to 6 (very applicable)
End of the week		
Perceived physical exertion	How physically strenuous has this week been for you?	Ranging from 6 (very, very light strain) to 20 (very, very high strain)
Perceived mental exertion	How mentally strenuous has this week been for you?	Ranging from 6 (very, very light strain) to 20 (very, very high strain)
Performance pressure	How much performance pressure have you experienced this week?	Ranging from 0 (not pressure at all) to 100 (a very high amount of pressure)
Performance	How well did you perform in the past week?	Ranging from 0 (way below my potential) to 100 (at the highest level of my ability)

Some of the questions were adopted from existing questionnaires. Perceived physical exertion and perceived mental exertion have been adopted and translated from the 'Borg rating of perceived exertion' (RPE) scale (Borg, 1982). The REP however does not differentiate between physical and mental aspects. These were differentiated in the questionnaires that were used.

Physical recovery and mental recovery were adapted and translated from the 'total quality recovery' (TQR) scale (Kenttä & Hassmén, 1998). Again, the TQR does not differentiate between physical and mental aspects. These were differentiated in the questionnaires that were used.

Physical performance capability, mental performance capability, emotional balance, overall recovery, muscular stress, lack of activation, negative emotional state, and overall stress were all adopted and translated from the 'short recovery and stress scale' (SRSS) (Kallus & Kellmann, 2016).

Group atmosphere, self-efficacy, Sleep quality, Performance pressure, and Performance were added through a collaboration between the RUG and KCT.

The questionnaires were available in an online platform specifically developed for the KCT. The operators filled in this questionnaire on Mondays and Fridays on a smart device. The data was collected in a database that was accessible for the researchers. The questions with a range of 0-6 and 6-20 were multiple choice answers. The questions with a range of 0-100 consisted of a slider that could be used to answer the questions.

Analysis

Of the 43 participants, only seven filled in the questionnaire every week. Of those seven, one operator filled in a score of 100 out of 100 every week for the question that asked about how well the individual performed. Hence this operator was excluded from this study.

This left us with six participants that were deemed to have filled in the questionnaires well enough and could be used our analysis.

The smart watches that were provided for the operators could be worn on a voluntary basis. The six participants that filled in the questionnaire consistently enough, all chose not to wear the smartwatch they were provided on a regular basis, hence the smartwatch data was not included in this research.

In order to answer the question: “what factors relate to performance of individual operators during the assaulter course?”, we started by plotting all variables through time in graphs. This was done in Microsoft Excel. We did this separately for all six operators. To do this we normalized all variables into a range from 1 to 10. This allowed us to compare the trajectories of all variables.

To visualize and analyze the correlations between variables, a correlation network graph was made for all operators. This was done in Rstudio. Excel data files were imported into Rstudio. Data packages ‘corr’ and ‘readxl’ were used in the coding. The data package ‘corr’ was used to generate a network plot. In our data some variables had a perfect correlation. The data package was not able to process this. Thus, all correlations of 1 were changed to a correlation of 0.999. This caused the data package to be able to process all correlations.

Since we expected most variables to correlate to most other variables, we have chosen to focus solely on the stronger correlations. To keep the networks graphs legible, only correlations that were higher than 0.6 or lower than -0.6 were shown. These values kept the most amount of data in the graph without making it illegible.

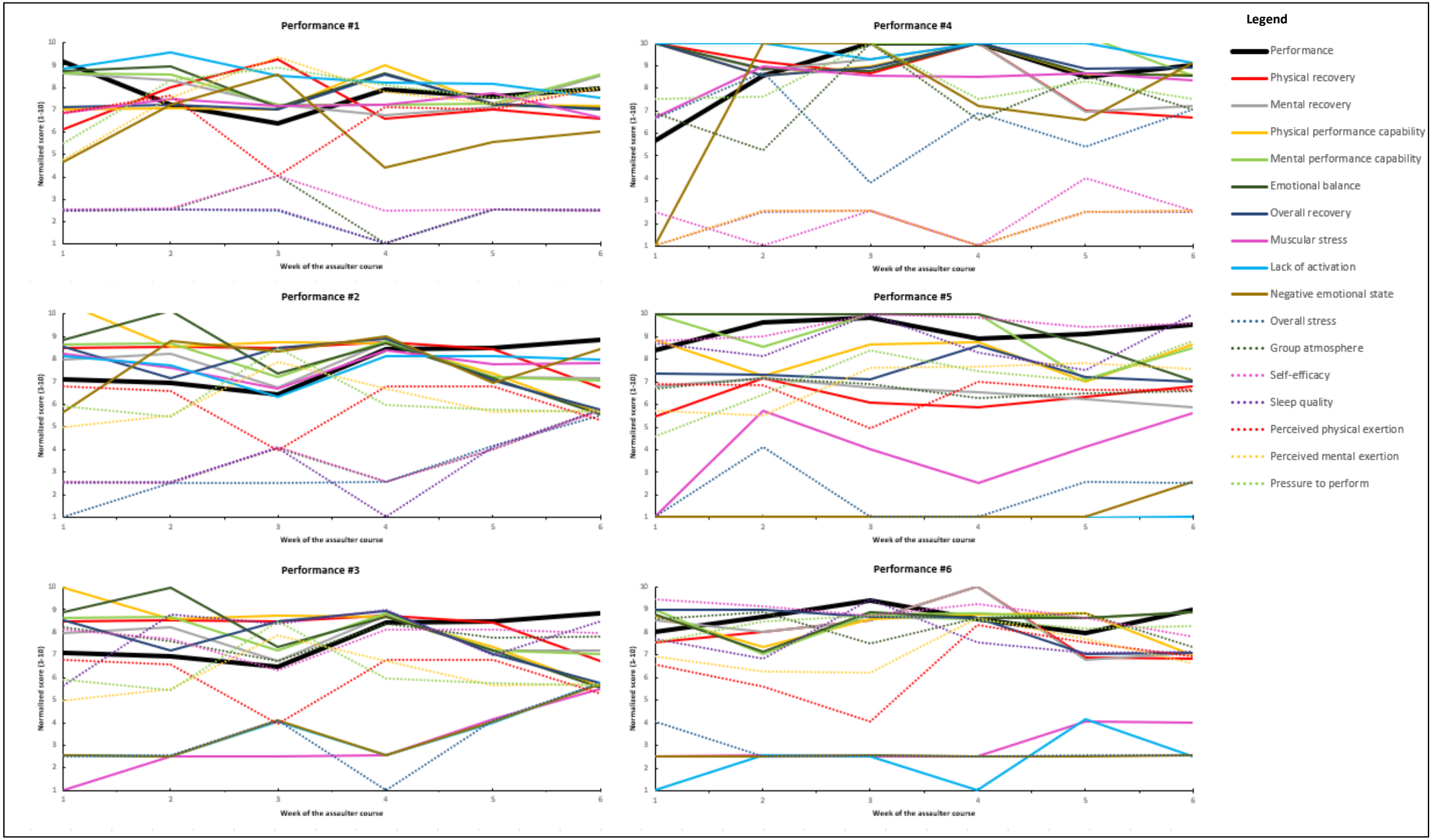
Results

Figure 1 displays a general visualization of changes in performance and the other variables changed over time. When looking at performance, we can see that subjective

performance of the operators is in general quite high. There is also little change in the performance through the week except for operator 4 that started off with lower performance compared to the rest but quickly improved. For the other variables we see that the operators in general give quite positive answers. For instance, overall stress, muscular stress, lack of activation and negative emotional state are in general scored low among all operators. While performance potential and recovery tend to be scores high. Considerable individual differences can be detected in terms of the specific levels and fluctuations of all variables.

Figure 1

Graphs of all measured variables

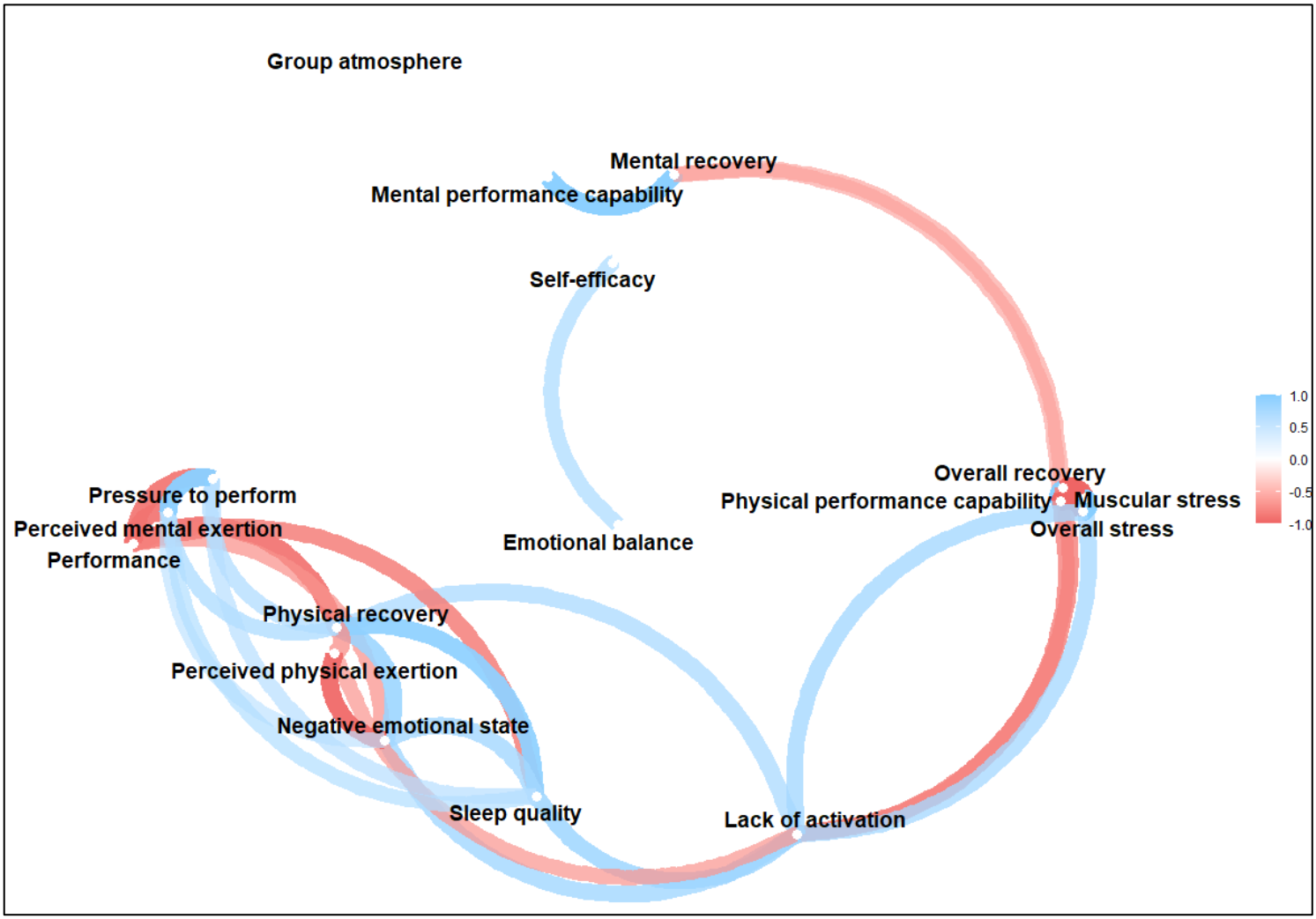


To visualize the correlations between the variables, correlation network graphs were made. These are shown below.

Operator 1's performance is highly correlated with physical performance capability (r=-0.91), sleep quality (r=-0.84), pressure to perform (r=-0.91), and negative emotional state (r=-0.71). In the network graph, we can see indications of a cluster of overall recovery, physical performance capability, muscular stress, and overall stress.

Figure 2

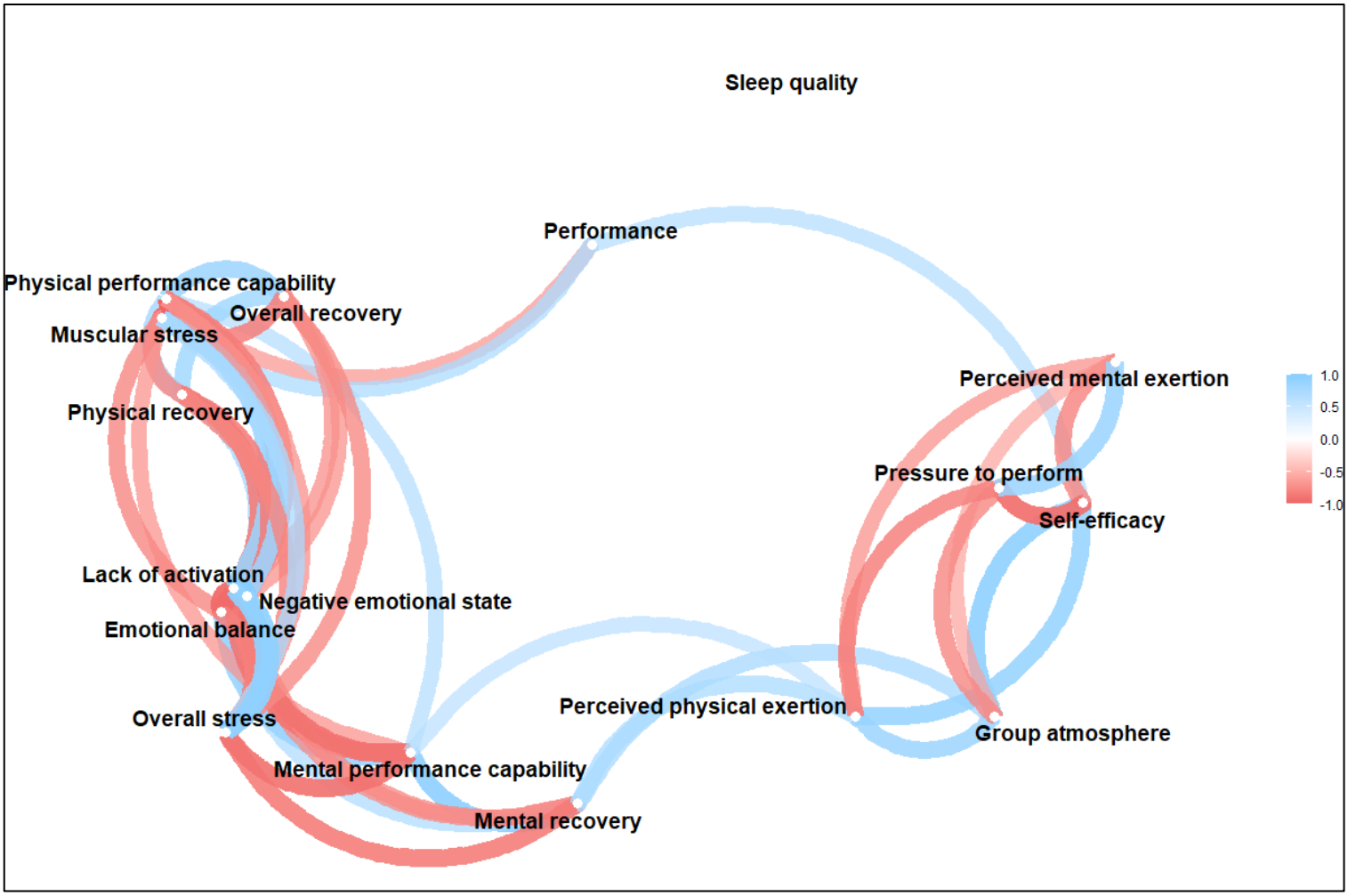
Correlation network graph #1



Operator 2's performance is correlated with muscular stress (r=0.72), physical performance capability (r=-0.69), and self-efficacy (r=0.68). From the network graph we can see indicators that physical performance capability, muscular stress, overall recovery and physically recovery form a cluster. Another cluster is formed by lack of activation, emotional balance, and negative emotional state.

Figure 3

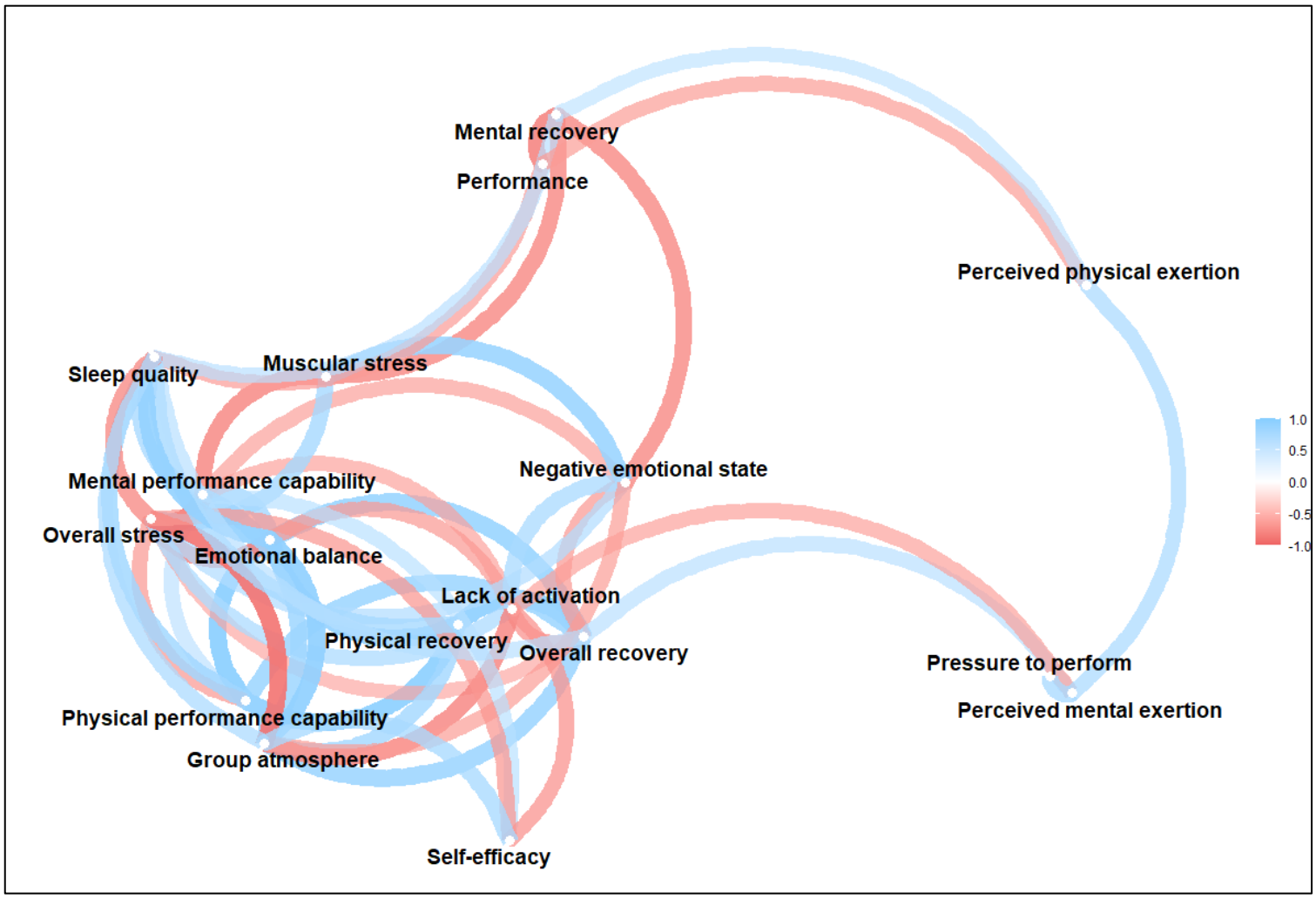
Correlation network graph #2



Operator 3's performance is correlated with mental recovery (r=-0.84), sleep quality (r=-0.66), and perceived physical exertion (r=-0.68). The network graph does not show one tight cluster, but rather shows that a lot of the variables of this Operator could be considered one singular big cluster.

Figure 4

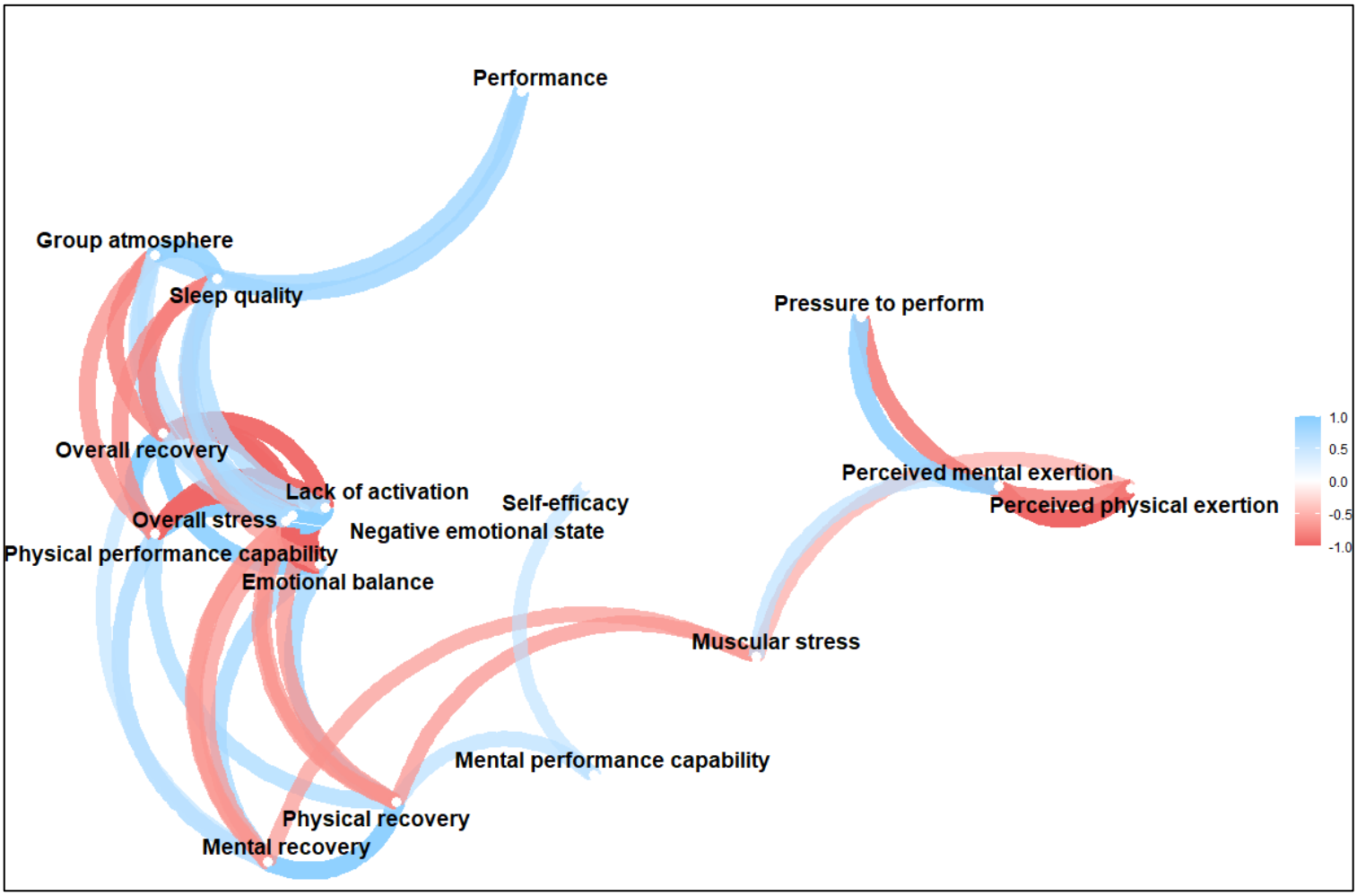
Correlation network graph #3



Operator 4's performance is correlated with sleep (r=0.83) and group atmosphere (r=0.81). The network graph shows indications of a cluster of overall stress, lack of activation, negative emotional state, and physical performance capability.

Figure 5

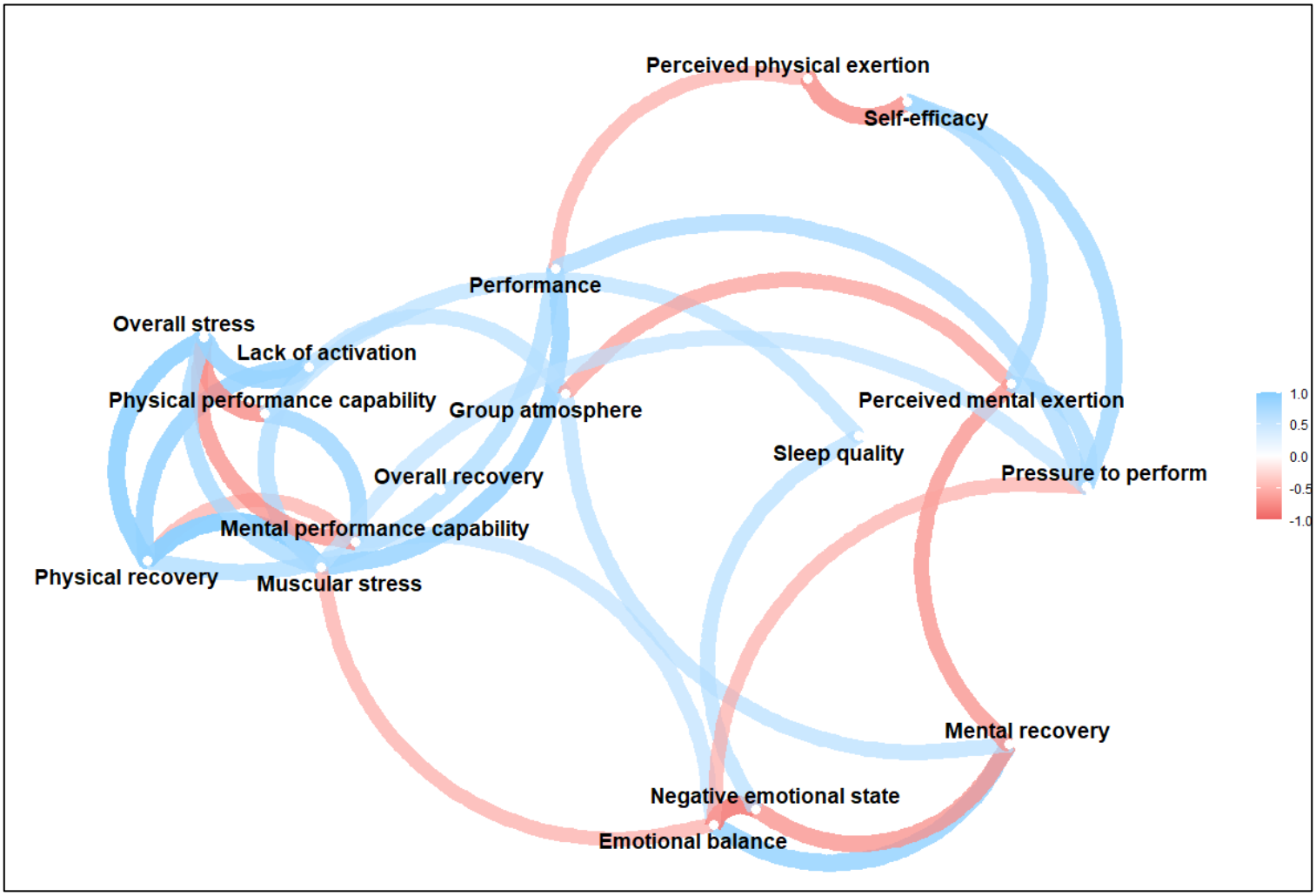
Correlation network graph #4



Operator 5's performance is correlated with physical recovery (r=0.73), muscular stress (r=0.86), perceived physical exertion (r=-0.61), and pressure to perform (r=0.75). The network graph does not show one tight cluster but shows that a lot of the variables of this Operator are positioned quite close together.

Figure 6

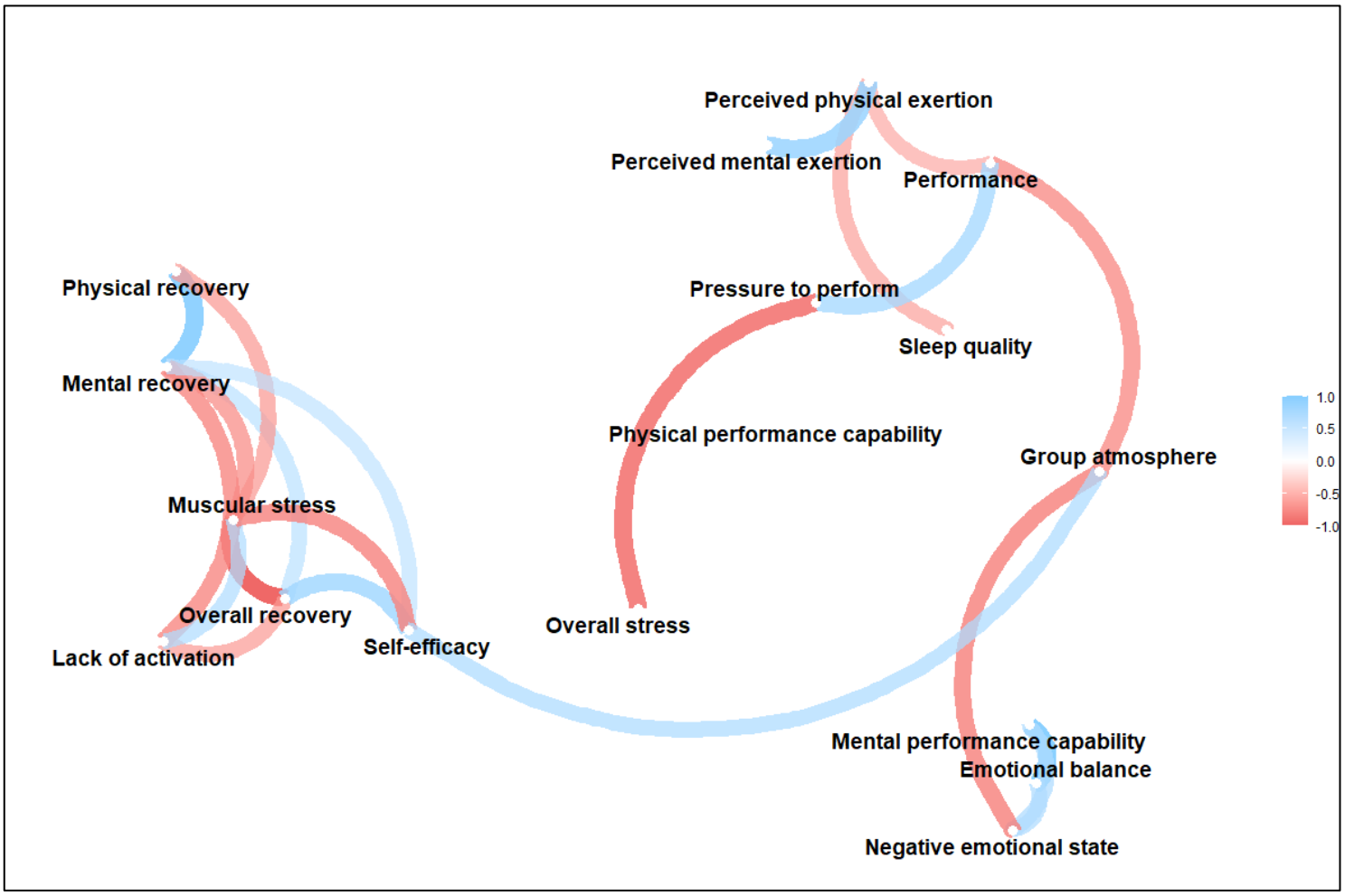
Correlation network graph #5



Operator 6's performance is correlated with group atmosphere (r=-0.76), pressure to perform (r=0.77), and perceived physical exertion (r=-0.61). There are indications of a cluster of mental performance capability, emotional balance, and negative emotional state.

Figure 7

Correlation network graph #6



Taken together, when comparing the correlations between performance and other variables of all operators we find little similarities. There are multiple contrasting correlations, for example, operator 4 showed a positive relationship between group atmosphere and performance, but for operator 6 a negative relationship between group atmosphere and performance was evident. The same applies for the clusters in the network's graphs. For example, for some operators there seem to be clusters containing mostly physical related variables (operator 2), but for other operators the physical related variables do not cluster together (operator 4).

Discussion

The aim of the current research was to gain a better understanding of what factors relate to performance of operators during the assaulter course of the KCT. Therefore, we examined operators during their training period. In doing so we applied an individual focus, since this has not been done before in a military context.

First, we found that all operators rate their subjective performance high, despite going through a tough, demanding training course. Performance also stayed relatively consistent throughout the six weeks. We found that for all operator's negative emotional state, lack of activation, overall stress and muscular stress were relatively low. The other variables were all relatively high. This indicated that despite going through a rough period, the operators were in general able to function well. This may relate to strong physical and psychological characteristics that the operators possess (Beal, 2010; Gucciardi et al., 2021)

Relation to performance

Even though we found a general trend in the data where all operators seemed to be doing well, we found large differences in how factors relate to performance between operators. For example, in the network graphs we see a negative correlation between quality of sleep and performance for operator 1 (r=-0.84) and 3 (r=-0.66) but a positive correlation

for operator 4 (r=0.85). In the same vein, the correlation between the pressure to perform and performance was positive for operator 5 and 6, but negative for operator 1.

In some of the network graphs we can see indications of clusters. For operator 6 a cluster seemed to consist of psychological variables, including: mental performance capability, emotional balance, and negative emotional state. For operator 2 we see a cluster that seems to consist of physical variables, including physical performance capability, muscular stress, overall recovery and physically recovery form a cluster. Operator 1 has a similar cluster made of: recovery, physical performance capability, muscular stress, and overall stress. Interestingly other networks graphs such as operator 6's does not show the same physical cluster. These results suggest that a group-based model would not have worked on our data, but an individual model should be used. This is in line with the findings within the sports field (Molenaar & Campbell, 2009; Neumann et al., 2021; Van Geert, 2014). These finding within sports show that the relatively new focus on the individual athlete should probably also be applied to operators in the military field. Thus, even in suboptimal performance conditions with little time for recovery, sleep loss and other conditions that would normally impact performance, the individual differences between operators are still big enough to warrant an individual focus on performance.

This insight can be used to gain an understanding of what an individual operator might need to gain an optimal performance. For example, some operators might need perform well while being angry and tense while others might do better while being calm, as supported by Hanin (2000) for athletes. The network graphs we produced could be used the understand how the performance of those operators work. It can give us insights in how these operators differ from each other and how we can help them perform even better.

Even though variables with strong correlations with performance fluctuate, performance stays constantly high for all operators. This suggest to us that the fluctuations of

these variables remain within a range where their impact on performance is not very strong. For example, the operators did not get their recommended hours of sleep every night, but our results suggest that they still got enough sleep to adequately perform. It seems that, overall, the needs of the operators were being met to a degree where they could perform adequately. However, the operators should not just perform adequately they need to perform optimally. We suggest that group level analysis and results can be used to make the whole group of operators perform adequately which is in line with the findings of Glazier & Mehdizadeh (2019) for athletes. However, as in line with finding in the sports field (Den Hartigh et al., 2018; Hamaker et al., 2005; Molenaar, 2004; Molenaar & Campbell, 2009; Neumann et al., 2021; Van Geert, 2014) when adequate performance in not enough we suggest that there is a need for an individual approach since there are large differences in what individual operators need to perform optimally.

Finally, we found that for some operators, clusters of variables exist that seem closely related to each other. This suggests that researches within the military field that look at one single variable's impact on performance (e.g Kavanagh, 2005, Kyröläinen et al., 2008) might be influenced by other closely related variables. For example, sleep loss might affect emotional balance, in turn affecting performance. Thus, focusing only on the sleep loss might not show the opportunity for emotional support to increase performance. This too is in line with recent finding in the sports field (Den Hartigh et al., 2018) and follows suggestions made in the military field (Grandou et al., 2019; McFarland, 2011; O'Leary et al., 2020). We suggest that to help operators reach optimal performance, we need to gain an insight in how variables impact each other and how this broad view of variables might impact performance.

Limitations and future direction

Overall, this research shows that trying to understand the performance of operators, an individual and broad approach should be used. However, a few limitations should be noted.

Firstly, we originally planned to include more participants where we would use the data of all 43 participants and the data provided by the smartwatches. Since the instructors did not spend much emphasis on getting the participants to fill in the questionnaire most operators did not provide reliable entries. This might have skewed our selection of participants where the most motivated or agreeable operators filled in our questionnaire. However, withing the special forces, sample size will likely always be a challenge since these forces tend to be relatively small.

Secondly, all data for this research was collected subjectively. It could be that different variables are impacted differently by this. For example, the operators had to compare their muscular stress with the worst soreness they have ever had. However, it could well be that for the subjective performance question, performance was compared to the performance of the other operators. This raises the question if you can compare questions that ask participants to compare to their best/worst state ever with questions that, indirectly, ask participants to compare themselves to the other participants.

Thirdly, another aspect of the subjective questions might be the operators trying to give desirable answers to make it seem like they are good operators. The military tends to have cultures where it can be frowned upon to show weakness. This might cause these operators to omit that they did not perform well or that they felt unfit.

However, the high performance scores may also have another reason. Before the training period where we collected our data, the operators went through an even rougher training period. This might have caused the operators to find this training period under study relatively easy even though it was still a tough period. Combined with our data being collected subjectively, this could have influenced the answers the operators gave. For example, 4 hours of sleep could now be regarded as ‘normal’ since in the previous course the operators only got to sleep for 2 hours.

Fourthly, since data was collected subjectively, the objective relations between variables might be different to what we found. For example Lauderdale et al. (2008) found large differences between self-reported and objectively measured hours of sleep, where they suggest that in some instances participants overestimated their sleeping hours by 1.3 hours. Similar results have been found for self-reported physical activity and direct measurements (Prince et al., 2008). The same might be happening to our participants, where their questions might differ from objective reality. However, both researches mentioned were done on general population. The discipline of army personnel might make for more accurate self-reported data, whereas the culture of toughness in army personnel might make the self-reported data less accurate.

Future research may focus more on objective data. Some variables of this research are relatively easy to collect objectively. Performance could be split into physical and psychological performance with different tests that could be performance when in a fresh state (maximum recovery) and during a non-fresh state (compromised recovery) during the training. Smartwatches provide the possibility to measure variables such as sleep quality, recovery, perceived physical exertion, and performance capability in an objective manor. Thus, it would be interesting to repeat this research with the inclusion of objective and subjective measurements to see if there is a difference between measurement types. This could implicate that in order to maximize performance, subjective measurements should not be trusted but measured objectively. This has already been proven to be effective for both the sports setting (e.g. Lee et al., 2017; Treff et al., 2021) and the military setting (Friedl, 2018; Kallinen & Ojanen, 2021; Murdock & Hagen, 2018), albeit still being in testing phases within militaries.

In addition, repeating similar research to ours in different training weeks might help further the understanding of this field. For example, repeating this research during an even

tougher training period might provide results with a higher contrast. In our research we see that performance remains relatively high throughout the weeks. When in an environment that pushes operators to the limit where performance starts to drop, we might find which factors can cause that drop in performance. This might give cleared understanding of what the most important factors are that are detrimental to performance and should have priority when extreme conditions are unavoidable.

Our final suggestion is to use the findings of this research to see if it is possible to use an individualized approach to actually enhance performance of operators. For example by letting half of the group of operators fill in the questionnaire and generating network graphs. The results from the network graph could be used to find individual interventions, where it could be tested if those individualized interventions ultimately lead to better performance. This could test if the theory can work for practical results.

Conclusions and implications

In our efforts to understand what factors relate to the performance of operators during the assaulter course of the KCT we found, in general, the subjective performance of operators was high throughout the entire course. There were many variables strongly related with performance, but for different operators these correlations were vastly different. We also observed that most variables correlated with other variables, showing the complex nature of performance. This calls for an individual approach where multiple variables and their underlying correlations are considered when trying to understand or enhance performance.

In addition, we hope to help the KCT understand what causes some operators to do well. Within the KCT multiple people in leadership positions said that some operators ‘just have *it*’. Our results suggest that the cause of this ‘*it*’ factor differs between operators. Different operators have different variables that relate to their performance, thus, to help maximize performance, the KCT would first have to figure out what the individual *‘it’* factor

is per operator. The KCT would need to individually check with their operators what they need and to provide individualized interventions for their operators.

For the KCT this implies that the group needs of the operators during the assaulter course are being met to a degree where performance is relatively high across the board. In order to get operators to perform optimally, a one-size fits all approach will not bring optimal performance. This is in accordance with the increasing interested in an individual approach to performance in sports (Den Hartigh et al., 2018; Hill et al., 2021; Kellmann et al., 2018; Neumann et al., 2021).

To conclude, within the military field, most research takes a group-based method where they focus on the impact of a single variable on performance(e.g. Conkright et al., 2020; Hatzigeorgiadis et al., 2011; Knapik et al., 1990). While these do have their use to get the general performance to an acceptable level. This group approach will plateau, and will not lead to maximal individual performance (Glazier & Mehdizadeh 2019). In order to have every operator perform to their maximal potential, every operator will need different things and interventions. Thus, when maximizing performance for operators, an individualized approach should be used that takes multiple variables into account.

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