Flight Performance Aspects During Military Helicopter Flights

Yuval Steinman; Marieke H. A. H. van den Oord; Monique H. W. Frings-Dresen; Judith K. Sluiter*

INTRODUCTION: A flight is composed of many flight performance aspects. However, not all of these aspects are equally important for the success and safety of a flight. When investigating the influence of a stressor on flight performance, it is important to understand not only which flight performance aspects are important for the success and the safety of the flight, but also which of these aspects will most likely be affected by reduced alertness.

METHOD: A total of 136 helicopter pilots of the Royal Netherlands Air Force (RNLAF) of all qualification levels were invited to participate in a three-round ranking Delphi study.

RESULTS: A total of 41 (30%) helicopter pilots completed the first questionnaire round and 20 (77%) flight instructors completed the ranking round. The top ten skills elements comprised seven nontechnical skills (NTS), namely, awareness of the environment, decision making, workload management, stress management, planning and coordinating, general knowledge, and basic fitness; and three technical skills (TS), that is, advanced aircraft handling, flight maneuvers and procedures, and abnormal and emergency procedures. The top three ranked skill elements (awareness of environment, decision making, and workload management) were considered by the flight instructors to be highly influenced by reduced pilot alertness.

CONCLUSION: NTS are considered more important and more affected by reduced pilot alertness during operational helicopter flight compared to TS.

KEYWORDS: pilots, reduced alertness, technical skills, non-technical skills.

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In military flight, pilots must maintain a high performance level to ensure flight safety. During flight pilots are exposed to different internal and external stressors that can affect their performance. Therefore, determining the influence that these stressors might have on pilots' performance is important for understanding their effects and mitigating possible threats to flight safety. Examples of stressors that have been shown to negatively influence cognitive and piloting performance are alcohol, drug use, fatigue, and hypoxia.[12] The effect of alcohol, drug use, and fatigue on piloting skills are well documented.[1,6,12] A limited number of studies[11,20,30] have attempted to measure the effect of hypoxia on flight performance in a simulated flight environment. However, the results of these studies are inconclusive.

One way in which pilots' flight performance can be negatively affected by the stressors mentioned above is through a reduction in pilots' alertness levels.[13,17,30] Reduced alertness levels have been shown to negatively influence cognitive performance,[31] and impair tasks that require vigilance, attention, and accuracy.[32]

Over the years, different techniques have been used to monitor and evaluate pilots' flight performance. However, no fully accepted or scientifically validated approach dedicated to the measurement of pilot performance exists. The complexity of the tasks a pilot needs to perform during flight makes it

*Posthumously.
From The Royal Netherlands Air Force, Center for Man in Aviation, Soesterberg, The Netherlands; and Amsterdam UMC, University of Amsterdam, Coronel Institute of Occupational Health, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands.

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Address correspondence to: Yuval Steinman, Amsterdam UMC, University of Amsterdam, Coronel Institute of Occupational Health, Meibergdreef 9, 1105 AZ Amsterdam, The Netherlands; y.steinman@amc.uva.nl.

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difficult to develop a single overall scale for the evaluation of performance.[26]

A flight is composed of many flight performance aspects. However, not all of these aspects are equally important for the success and safety of a flight. In addition, when investigating the influence of a stressor like hypoxia on flight performance, it is important to understand not only which flight performance aspects are important for the success and the safety of the flight, but also which of these aspects will most likely be affected by reduced alertness.

To our knowledge, there is no overview of the flight performance aspects in respect to their importance during operational military flights. In addition, we could not find literature regarding which of the flight performance aspects might be most influenced by reduced pilot alertness levels.

The main aim of the present study was to determine which flight performance aspects are most important during operational military helicopter flights. The secondary aim was to determine which of the important flight performance aspects are most affected by reduced pilot alertness levels.

METHODS

Subjects

A total of 136 helicopter pilots of the Defense Helicopter Command (DHC) of the Royal Netherlands Air Force (RNLAF) were invited to participate in this study. We sent the first questionnaire to a large group of pilots as we suspected that response rate would not be high and we wanted to receive as much information as possible. These pilots were chosen because the nature of their profession means they can be regarded as experts and are qualified to determine which flight performance aspects are most important during operational helicopter flights. A variety of helicopters pilots participated in this study (i.e., pilots of attack, transport, and navy helicopters), which enabled the collection of a wider range of data.

The pilot population was composed of pilots and flight instructors of all qualification levels, namely copilots, pilots, tactical trainers level A (TTA), tactical trainers level B (TTB), tactical trainers level C (TTC), type rating instructors (TRI), and type rating examiners (TRE). To be included in the study, the pilots needed to be active DHC pilots, and they had to be certified to fly at least one of the helicopter types within the DHC (Apache, Chinook, Cougar, or NH90). We included all pilot qualification levels from different airframes in the study to ensure that the consensus reached was based on the knowledge of all qualification levels within the pilot community.[2]

A statement was provided by the medical ethics committee of the Academic Medical Center Amsterdam declaring that no ethics approval was necessary for this study (W17_292# 17.334).

Procedure

In the present study data were collected using a ranking Delphi method. A Delphi study is composed of a series of questionnaire rounds sent to chosen experts in the area of interest. As described by Schmidt,[27] in a ranking Delphi data is collected in three phases: the purpose of the first phase is to discover issues relevant to the topic, in the second phase the most important issues are determined, and in the third phase the issues are ranked in order to reach consensus. The present study was performed in accordance with the method provided by Schmidt for the performance of a ranking Delphi.[27]

Pilot recruitment started after permission was granted by the commander of the DHC to conduct the study. The research team was provided with a list of all the pilots and flight instructors of each of the helicopter types and their qualification levels. It is suggested that in a homogeneous group, 10 to 18 experts might be enough.[3,23] Using this list, and taking into consideration the number of pilots available in each qualification level, the team randomly selected and invited, by email, a maximum of 10 copilots, 10 pilots, and if available 5 out of each of the flight instructors qualification levels: TTA, TTB, TTC, TRI and TRE, of each helicopter type, to participate in the study (**Table I**). If more pilots of a certain qualification level were registered than the number needed for this study, a random selection was made of the pilots, who were then invited to participate in the study. Because of the small number of flight instructors (TTA, TTB, TTC, TRI and TRE) in each squadron, and taking into consideration possible nonresponse and drop out, all flight instructor levels were grouped into one group in order to reach the number of experts required for a Delphi study.

For the randomization process, each of the pilots on the list was assigned a number. Using a web-based randomization program (www.randomizer.org), a random list of numbers, corresponding with the total number of pilots in each of the qualification levels, was created. Pilots were invited to participate in the study if their number on the list fell within the number of pilots needed per qualification level. If a pilot did not want to participate in the study, the next pilot on the list was invited. This process continued until the desired number of pilots per qualification level was reached or no more pilots in that group were available.

A web-based questionnaire (Qualtrics, Qualtrics LLC, Provo, USA) was distributed to all participating pilots and flight instructors via a link in an email sent to their personal military

Table I. Number of Pilots of the Different Helicopter Types and Their Qualification Levels, and Total Number of Pilots per Helicopter Type and Total Qualification Level.

	PARTICIPANTS							
HELICOPTER TYPE	**COPILOTS**	**PILOTS**	**TTA**	**TTB**	**TTC**	**TRI**	**TRE**	**TOTAL**
Chinook	10	10	2	5	3	7	5	42
Cougar	8	9	3	4	1	3	3	31
Apache	10	7	16	5	5	9	7	43
NH90	5	6	5	0	0	4	0	20
Total	33	32	26	14	9	23	15	136
								152*

TTA: tactical trainers level A; TTB: tactical trainers level B; TTC: tactical trainers level C; TRI: type rating instructors; TRE: type rating examiners.
* There is a difference between the total number of pilots and the total pilots' qualification level because some flight instructors can be qualified at more than one level. For example, a flight instructor can have TTB, TTA, and TTC qualifications.

account, which also provided information regarding the study. Before starting the questionnaire, the pilots had to confirm that they wanted to participate in the study. By clicking on "Yes, I want to participate in this study," the pilots acknowledged that they had read and understood the information regarding the study that was presented to them. This was followed by a questionnaire instruction letter explaining the purpose, what was expected of them, and the deadline for completing the questionnaire. The pilots were also instructed to complete the questionnaire by themselves and not share information regarding the questionnaire with other pilots.

The present study consisted of three questionnaire rounds. The first questionnaire round involved all the pilots, regardless of their qualification level. The second and third questionnaire rounds concerned only the flight instructors (TRI, TRE, TTA, TTB, and TTC). In the present study we considered the helicopter flight instructors as the most qualified to determine which flight performance aspects are important during operational flight. In order to become a flight instructor in the RNLAF they need to comply with strict qualification and experience rules described in the documents: "Military Aviation Requirements – Flight Crew Licensing"[19] and "Military Aviation Requirements Operations."[18] The flight instructors are checked regularly and need to meet the requirements of their pilot qualification level. In addition, we asked them to evaluate aspects that fall within their knowledge and expertise as they apply them each and every day during the training and evaluation of other helicopter pilots' performance.

The purpose of the first questionnaire round was to gather as much information as possible regarding the flight performance aspects that the pilots and flight instructors consider most important during operational flight.

The questionnaire was composed of two parts. In the first part, the pilots answered general questions regarding the helicopter type they fly, their most relevant qualification level, total number of flight hours, and total number of flight years. The second part was composed of two open questions. The first asked the pilots to list a maximum of ten flight performance aspects that they consider most important during operational military flights while occupying the back seat of an Apache helicopter cockpit or the left cockpit seat of a Chinook, Cougar, or NH90 helicopter, and to provide a short explanation for their choice. The second question asked the pilots to again list a maximum of ten flight performance aspects they consider most important during operational military flights, but this time while occupying the front seat in an Apache helicopter cockpit or the right cockpit seat of a Chinook, Cougar, or NH90 helicopter, and to provide a short explanation for their choice. This was done as there is a difference in all helicopter types between the tasks the pilots perform depending on which of the cockpit seats they occupy.

Because the pilots have busy schedules, they were given 6 wk to complete the first questionnaire. During this period, the pilots received three reminders to fill in the questionnaire. Approximately a week after the pilots received the questionnaire, a presentation on the study was given at each of the squadrons in order to stimulate participation in the study by emphasizing its importance, and to answer any questions the pilots may have had regarding the study. The questionnaire could be completed in English or Dutch.

The completed questionnaires were exported from the web-based questionnaire to SPSS (IBM SPSS Statistics 24, IBM, Armonk, NY, USA). Answers given in Dutch were translated into English. The data were then imported into MaxQDA software (VERBI Software GmbH, Berlin, Germany) for analysis. Duplicates and answers that consisted of a single word without additional explanation were, in general, excluded from the analysis, as it was hard to determine what the pilot meant by his answer. With the help of a helicopter flight instructor who was not participating in the study, answers provided by the pilots that describe the same aspect were sorted into groups. After completion of this phase each group was provided with a label that described the aspects in that group most accurately. Afterwards, a list containing all labels was created that was used in the second round. If the total number of labels in the list would be around 20, the first round would immediately be followed by the ranking round.[22,27]

In the second questionnaire round a list containing the labels from round one in a random order was sent via email only to the flight instructors (TRI, TRE, TTA, TTB and TTC) who had agreed, in round one, to participate in the study. In order to reduce the labels on the list used in the third round to a manageable size of approximately 20 labels, the flight instructors were asked in the second questionnaire round to select (not rank) out of the list they received the 20 labels they found most important. They did so by dragging the relevant 20 labels out of the list and dropping them into a box. The researcher identified the labels selected by over 50% of the flight instructors.[22,24] These labels were retained for use in the third questionnaire round.

In round three, the instructors, who completed the second questionnaire, received a list of the selected labels from the second questionnaire round arranged in a random order, and were asked to rank ten of the labels on a scale of 1–10 (1 = most important, 10 = least important). The instructors were also asked to rank the ten labels that they had chosen in response to the first question, but this time in the order in which they thought they were influenced by reduced pilot alertness levels.

Analysis

The completed questionnaires from the third round were analyzed for the most important labels. We defined "most important" as when at least 80% of the flight instructors ranked a label in their top ten.[4,10] There is no accepted standard for the percentage of agreement in a Delphi study. Percentage of agreement is usually 60% agreement or higher with the median being 75%.[10] It was important for us to determine which of the flight performance aspects reported by the pilots are most important during flight. Therefore, setting the agreement criteria to 80% indicated that a label was considered important by a large majority of the flight instructors. If ten or more labels were ranked by ≥ 80% of the instructors, this would indicate satisfactory consensus and the ranking phase would be considered complete. However, if ten labels were not ranked by 80% of the flight instructors, consensus would be assessed using Kendall's coefficient of concordance (Kendall's W), as described by Schmidt.[27]

Determination of the labels chosen by the flight instructors that are most influenced by reduced pilot alertness was done by calculating the mean score of each label. The label with the lowest mean score was considered the most affected by reduced pilot alertness, while the label with the highest mean score was considered the least affected by reduced pilot alertness.

RESULTS

A total of 41 (30%) pilots (18 pilots and copilots, and 23 flight instructors) of all 4 helicopter types completed the first questionnaire round. The characteristics of the helicopter pilots and flight instructors are shown in **Table II**.

A list of 449 aspects that the pilots and flight instructors found most important during operational military helicopter flights was drawn upon the basis of their responses to the first questionnaire. After applying the exclusion criteria and removing duplicates, 252 aspects remained. The 252 aspects were sorted into a total of 21 groups, each group containing terms describing the same aspect. After a discussion within the research group it was decided that the determination of the label that was provided to each group would be based on the helicopters training manuals and the no-technical skills manual used by the Royal Netherlands Air Force (MilNoTechs, Instructions for use of Military NoTechS; Royal Netherlands Air Force, 2017; version 5.5; Training Manual DHC AH-64 Apache Type Rating. Defense Helicopter Command, 2017 Contract No.: 2016009378, Training Manual DHC AS-532 Cougar Type Rating Pilot. Defense Helicopter Command, 2017 Contract No.: 2016011395, Training Manual DHC CH-47 Chinook Type Rating. Defense Helicopter Command, 2017 Contract No.: 2016011390, Training Manual DHC NH-90 Type Rating. Defense Helicopter Command, 2017 Contract No.: 2017004999). This way the flight instructors that participated in the following rounds were presented with a list of labels that were familiar to them. The labels given to the 21 groups were composed of 5 labels describing technical skill (TS) elements and 16 labels describing nontechnical skill (NTS) elements[8] (**Table III**).

As stated, the number of labels in the list amounted to 21, which is close to the limit set for the maximal number of labels needed to start the ranking round (20 items). Therefore, the planned second questionnaire round (aspects selection) was skipped and we proceeded to the ranking round (round three).

The ranking questionnaire round was sent to 26 flight instructors (TRI, TRE, TTA, TTB, and TTC) who had agreed to participate in the study. Of these instructors, 20 (77%) completed the questionnaire. The ranking results of the 21 skill elements are presented in **Table IV**. Kendall's W showed that a strong consensus existed among the flight instructors ($W > 0.777$).

Analysis of the first ranking question, where the instructors needed to rank the ten skill elements they find most important during operational military flights, shows that "awareness of environment" and "decision making" were ranked by 85% and 80% of the instructors, respectively. "Workload management" and "stress management" were ranked by 75% of the instructors, and "advanced aircraft handling" and "flight maneuvers and procedures" were ranked by 65% and 60% of the pilots, respectively. Both "abnormal and emergency procedures" and "planning and coordinating" were ranked by 55% of the instructors, and "general knowledge" was ranked by 50%. All other skill elements were ranked by < 50% of the instructors.

An analysis of the second ranking question (Table IV), where the pilots needed to rank the influence of reduced pilot alertness level might have on the elements they ranked in the first question, shows that "alertness" received the lowest mean ranking score (1.4). It is followed by "awareness of environment," "workload management," and "decision making," which received mean scores of 3.0, 3.3, and 3.7, respectively. The element "awareness of time" received a mean ranking score of 4.3 and "stress management" a mean score of 4.6.

DISCUSSION

The aim of the present study was to determine which flight performance aspects are considered most important during operational military helicopter flight, and which of those aspects are most influenced by reduced pilot alertness. We identified 21 skill elements that represent the majority of flight performance aspects reported by the pilot population. The top ten skill elements were composed of seven nontechnical skills (NTS) – namely awareness of environment, decision making, workload management, stress management, planning and coordinating, general knowledge and basic fitness, and three technical skills (TS), that is, advanced aircraft handling, flight maneuvers and procedures, and abnormal and emergency procedures.

Table II. Characteristics of the Helicopter Pilots and Flight Instructors Who Completed the First Questionnaire.

HELICOPTER TYPE	TOTAL NO. OF PILOTS (NO. OF PILOTS AND COPILOTS; NO. OF FLIGHT INSTRUCTORS)	TOTAL NO. OF FLIGHT YEARS MEAN (± SD)	TOTAL NO. OF FLIGHT HOURS MEAN (± SD)
Chinook	11 (6; 5)	13 (± 2)	2015 (± 412)
Cougar	4 (3; 1)	10 (± 2)	1787 (± 517)
Apache	23 (8; 15)	11 (± 1)	1754 (± 186)
NH90	3 (1; 2)	17 (± 7)	2533 (± 933)

Total number of pilots per helicopter type (number of pilots, copilots, and flight instructors), total number of flight years and total number of flight hours data are expressed as mean and SD.

Table III. Overview of the Technical Skills (TS) and Nontechnical Skills (NTS) Labels, and Examples Taken from the First Questionnaire Round of Flight Performance.

TECHNICAL SKILLS (TS)		NONTECHNICAL SKILLS (NTS)	
LABEL	EXAMPLE	LABEL	EXAMPLE
Preflight / mission preparation and checks	Mission preparation and planning, cockpit inspection	Basic fitness	Taking care of yourself, having slept well, having eaten well, physical fitness
Flight maneuvers and procedures	Basic flight skills, basic aircraft control, landing, takeoff	Stress management	Can handle stress or high workload
Normal and abnormal operations	Fuel system, engine, electrical system	Decision making	Option generation, risk assessment and option selection
Abnormal and emergency procedures	Engine failures, fire drills, transmission malfunction	Workload management	Divide attention between tasks, prioritization, determine which tasks are most important
Advanced aircraft handling	Evasive maneuvers, low level flight, confined, multiship flying	Providing and maintaining standards	Knowledge of procedures and regulations, work according to standards and procedures
		Awareness of time	Flight time and fuel calculations, think one step ahead of failures
		Alertness	Being awake, being sharp, task focused
		Supporting others	Cooperation between all crewmembers while performing tasks
		Awareness of environment	Situational awareness, knowing, understanding and interpretation of surroundings
		Planning and coordinating	Good preparation, performance planning, intel, backup plans
		Personality	Positive attitude, open to learning, willing to do the best job possible
		Use of authority and assertiveness	Leadership, assertiveness, take the lead when situation dictates
		Team building and maintaining	Motivate crew, cooperate, react positively, give feedback
		Awareness of personnel	Honesty, knowledge of physical and mental limitations of the crew
		Awareness of aircraft systems	Monitor the systems, analyzing emergencies, error recognition and correction
		General knowledge	Theoretical and practical knowledge to perform the task

In addition, the top three ranked skill elements (i.e., awareness of environment, decision making, and workload management) were considered by the flight instructors to be highly influenced by reduced pilot alertness, as they received the lowest mean ranking scores out of the top ten (the closer a mean ranking score is to the value of 1, the more influenced it is).

Of the top ten skills, the TS "flight maneuvers and procedures" received the lowest mean rank score (3.7), indicating that the flight instructors consider it to be an important skill element. This is not surprising, as without those skills a pilot cannot fly or properly control a helicopter.

In order to operate at a high level at the ever changing operational environment the aircrew must not only know how to operate the aircraft but must maintain a high up to date picture of the state of the environment.[14] A series of catastrophic aviation accidents, without primary technical cause, demonstrated the importance of NTS in reducing the likelihood of human error.[9] NTS are the cognitive and social skills that complement workers' TS (TS are the technical, tactical and procedural skills that are needed for flying an aircraft) and contribute to safe and efficient task performance.[8,9] During flight, poor NTS can increase the chance of error, which in turn can increase the chance for an adverse event, even if the pilot has high TS.[9]

Awareness of environment, decision making, and workload management play crucial roles during flight. These skills are interdependent, as both awareness of environment and workload management are crucial for the decision making process.[6,7] Decision making is generally defined as "the process of reaching a judgment or choosing an option."[8] It is a complex cognitive process where choices are made from among a number of alternatives, based on the information the aircrew has of the current situation, and risk assessment within a limited-time frame.[5,8] Studies have shown that errors in the decision making process contributed to 45% of accidents in the U.S. Air Force and 55% in the U.S. Navy.[28]

The results presented show that these three NTS skill elements, when ranked for the effect of reduced alertness on them, received the lowest mean ranking scores, indicating that the flight instructors consider them to be highly influenced by reduced pilot alertness. It has been suggested that reduced alertness levels likely impair tasks that require vigilance, attention, and accuracy.[16,32] Vigilance is defined as the ability to sustain attention to a task for a period of time[21] is essential for visual scanning[16] and maintaining awareness of environment.[29] Attention is essential for both awareness of environment and workload management; lapses in attention can result in loss of information that is not always detected by the subject.[32] For the

Table IV. Ranking Percentage and Mean Ranking Score of the 21 Technical Skills (TS) and Nontechnical Skills (NTS) Elements.

SKILL ELEMENT	NUMBER OF PILOTS	PERCENTAGE	MEAN RANKING SCORE	MEAN RANKING SCORE REDUCED PILOT ALERTNESS
Awareness of environment	17	85	4.7	3.0
Decision making	16	80	5.2	3.7
Workload management	15	75	5.3	3.3
Stress management	15	75	5.5	4.6
Advanced aircraft handling	13	65	5.5	5.2
Flight maneuvers and procedures	12	60	3.7	6.8
Abnormal and emergency procedures	11	55	5.0	6.4
Planning and coordinating	11	55	5.2	7.5
General knowledge	10	50	5.1	8.8
Basic fitness	9	45	5.6	8.2
Awareness of time	9	45	6.1	4.3
Awareness of personnel	9	45	6.8	5.3
Alertness	8	40	4.5	1.4
Supporting others	8	40	6.9	7.3
Providing and maintaining standards	7	35	6.6	6.0
Use of authority	7	35	8.1	6.0
Awareness of aircraft systems	6	30	5.2	6.8
Personality	6	30	5.3	8.7
Team building and maintaining	5	25	8.6	6.8
Normal and abnormal system operations	4	20	5.8	5.5
Preflight/mission preparation and checks	2	10	4.5	7.5

Number of pilots: number of pilots who ranked the element. Percentage: percentage of pilots who ranked the element out of the total group. Mean ranking score: mean ranking score of the element (the lower the mean score, the higher the importance during operational flights). Mean ranking score reduced pilot alertness: mean ranking score the element received for the influence that reduced pilot alertness level might have on it (the lower the mean score, the higher the importance during operational flights).

success of a mission it is essential that decision making be based on complete information gathered by the aircrew regarding the problem they are facing. Incomplete information as a result of reduced vigilance and attention, affecting the aircrews' awareness of environment and workload management, may result in failure of the mission. As mentioned previously, hypoxia causes a decrease in alertness levels.[30] An example to support our finding that the top three ranked NTS are more affected by reduced pilot alertness levels can be found in the study by Nesthus et al.[20] In their hypoxia study, they observed more errors, such as initiating premature flight maneuvers, failing to follow ATC instructions, missing approach, misreporting seeing the airport or airfield, etc., being made by the hypoxia-exposed group compared to the control group. Missing approach and misreporting seeing the airport or airfield can be attributed to reduced awareness of the environment, failing to follow ATC instructions can be attributed to workload management, and performing premature flight maneuvers and unsafe and high-risk piloting behaviors can be attributed to impaired decision making.[25]

In the present study 41 (30%) of the pilots invited to the study completed the first questionnaire. The purpose of the questionnaire was to gather as much information as possible from the pilots regarding the research topic. According to the literature in a homogeneous group few new ideas are generated when the group size is larger than 30 participants.[3] We observed that as the analysis of the answers progressed no new aspects were introduced by the pilots. This is not surprising as all helicopter pilots within the RNLAF work according to the same procedures and follow the same manuals. Therefore, recruiting more pilots for the first questionnaire round was not necessary.

There is no clear agreement among methodologists regarding the optimal size of a Delphi expert panel.[15] A total of 20 flight instructors completed the ranking questionnaire. The literature suggests that in a homogeneous group, 10 to 18 experts might be enough.[3,23] We think that both the group composition and the number of participants were sufficient to comply with the requirements of a Delphi study.

There is currently no consensus regarding the definition of an "expert" in the context of a Delphi study.[1] Various proposed definitions include one that is undisputable, namely that he or she is a representative of the professional group and has sufficient expertise. He or she should also have sufficient knowledge, experience, and the ability to influence policy.[1] In the present study, we included a large group of flight instructors who represent the target population of this study, who have sufficient expertise, knowledge, and experience, and who evaluate the flight performance of other pilots on a daily basis.

A lot of participants reported communications as an important aspect during flight; however, during the consolidation of all elements into a single element list by the researcher (YS), a communication element was not added to the 21 elements. The reason for this is that in the RNLAF, helicopter communications training is seen not as a separate NTS, but as a part of each of the various elements.

The results of this study have implications for the choice of performance parameters used in future studies examining the effect of different stressors on flight performance, because they support the use of NTS rather than TS for evaluating pilot performance. Further research in a simulated flight environment is needed to determine the effect of stressors on NTS.

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Authors and affiliations: Yuval Steinman, M.Sc., The Royal Netherlands Air Force, Center for Man in Aviation, Soesterberg, The Netherlands; Yuval Steinman, Marieke H. A. H. van den Oord, Ph.D., Monique H. W. Frings-Dresen, Prof., Ph.D., and Judith K. Sluiter, Prof., Ph.D. (posthumously), Amsterdam UMC, University of Amsterdam, Coronel Institute of Occupational Health, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands.

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