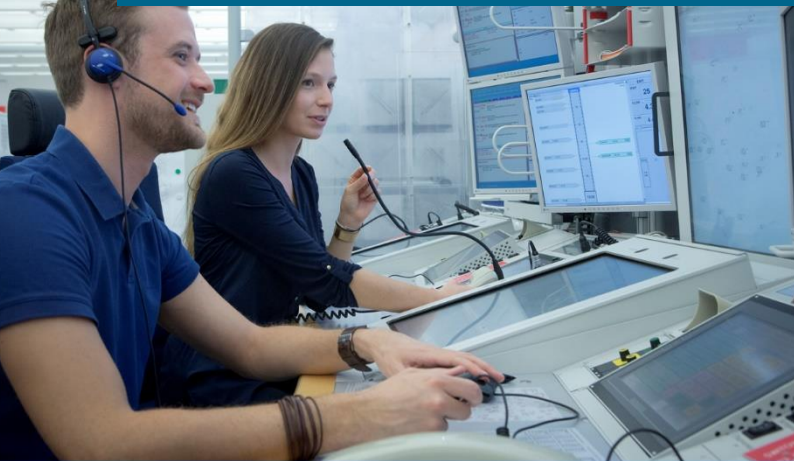# VALIDATING ATCO SELECTION AND TRAINING

A Large-Scale Study for DFS Deutsche Flugsicherung GmbH

Department of Aviation and Space Psychology, Institute of Aerospace Medicine, German Aerospace Center (DLR)

Document Properties

Title	Validating ATCO Selection and Training – A Large-Scale Study for DFS Deutsche Flugsicherung GmbH
Reference	Validating ATCO Selection and Training – A Large-Scale Study for DFS Deutsche Flugsicherung GmbH
Institute	Department of Aviation and Space Psychology, Institute of Aerospace Medicine, German Aerospace Center (DLR)
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Checked by	Hanna Willborn, Alexander Heintz, Dr. Yvonne Pecena
Approval by	Alexander Heintz, Dr. Yvonne Pecena
Date	8/23/2024
Version	1.0
File Name	DLR Project Report Validating ATCO Selection and Training

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Acknowledgments

Contents

1. Introduction and Objectives

Due to the elevated level of responsibility for controlling aircraft through a dense and complex airspace while adhering to strict safety standards, the job of an air traffic controller (ATCO) is highly demanding.

Selecting suitable personnel to work as ATCOs involves the identification and regular adaptation of the cognitive and psychological requirements for the position.

In addition to a requirements-based selection procedure, the quality of a selection procedure can be ensured through the evaluation of selection and training. Validation studies on selection and training are therefore an important part of quality assurance. More specifically, to assess the quality of a selection instrument, predictive validity is used as a measure to determine how well the outcome of this selection instrument can predict future training outcomes, i.e., performance and success.

The DLR selection for ab initio ATCOs is a multi-phase, multi-modal process starting with cognitive performance tests and finishing with an interview with the selection board. The selection process is certified according to DIN EN ISO 9001:2015.

After successfully passing the selection process and a medical examination, applicants start their DFS ATCO training with theoretical lessons and simulations, called initial training (IT). This is followed by supervised training on live traffic at a tower or center, called unit training (UT), primarily provided by on-the-job training (OJT).

Objectives of this Validation Study

- Assess predictive validity of the DLR selection procedure for DFS ATCO training

- Assess predictive validity of early ATCO training phases for the late ATCO training

- Further optimize DLR selection and DFS ATCO training

DLR Selection

DFS ATCO Training

Predictive Validity

Figure 1 Main objective of the validation study with pictures from DLR selection procedure and DFS ATCO training (Source of left photos: DLR, 2024; source right photos: DFS Deutsche Flugsicherung GmbH)

The objectives of the validation study to assess the predictive validity and further optimize the quality, efficiency, and cost of the selection and training processes led to the following main research questions, which focus on the investigation of relevant psychological aspects of assessments.

Main Research Questions

- How well can the selection test performance and additional selection information predict training performance and success?

- How well can specific biographical aspects predict training performance and success?

- How well can initial training performance predict unit training performance?

This public DLR project report provides an overview of the validation study and summarizes the main results. Moreover, it provides implications for selection and training. Accordingly, this report is primarily aimed at experts and practitioners in the field of air traffic control.

This DLR validation study on ab initio ATCO selection and training was funded by and conducted in cooperation with DFS Deutsche Flugsicherung GmbH.

2. DLR Selection

In this comprehensive validation study, selection tests from all phases of the DLR selection procedure and additional selection information were used as predictors.
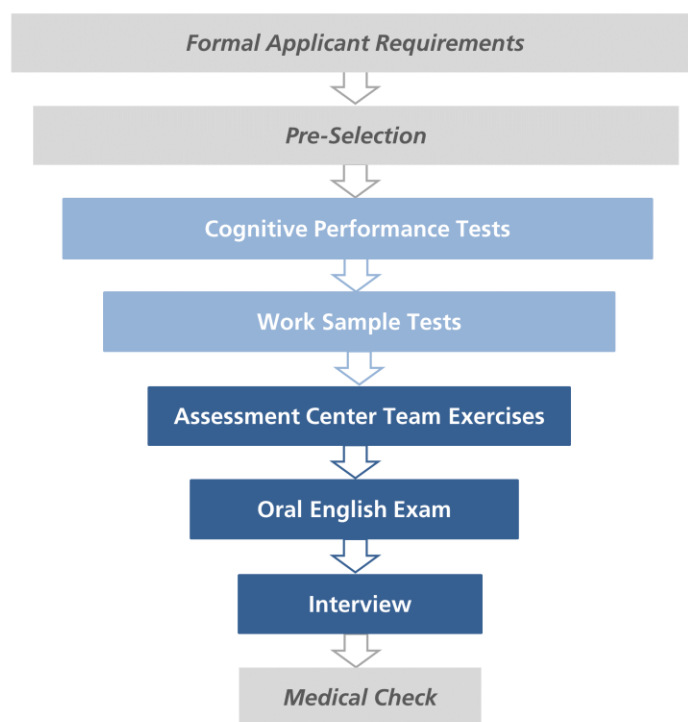
DLR Selection Procedure

Figure 2 Overview of DLR selection procedure for ab initio ATCOs (blue boxes)

The formal requirements for ATCO applicants (e.g. general higher education entrance qualification "Abitur" or equivalent) are defined and ensured by DFS Deutsche Flugsicherung GmbH. Furthermore, applicants were required to complete an online pre-selection biographical questionnaire at the time the sample was recruited. Applicants who fulfilled the requirements were invited to enter the DLR selection procedure. Today, DFS conducts a broader pre-selection process, including online testing, prior to the DLR selection procedure.

As part of the DLR selection procedure, applicants are asked to fill in a questionnaire to provide additional biographical information before they enter the first DLR selection phase. In the first selection phase, basic cognitive abilities and skills are tested with cognitive performance tests. This computer-based group testing is followed by work sample tests that assess multitasking abilities. Applicants who pass the work sample tests are invited to take part in team exercises which focus on how they work in a team with other applicants.

In the final DLR selection phases, applicants are tested in an oral English exam and a semi-structured interview is conducted by the selection board. Applicants who successfully pass this selection interview are recommended as psychologically suitable to start DFS ATCO training. Medical suitability for the ATCO profession is assessed by an aeromedical examiner after the DLR selection process.

Cognitive Performance Tests

The first selection phase assesses the cognitive performance of applicants and consists of 11 cognitive performance tests that cover four cognitive domains essential for ATCO training:

Memory

The ability to **memorize and recall** relevant visual and auditory information over a short time

Attention

Different aspects of attention for visual and auditory information, including selective attention, sustained attention, and vigilance

Speed of Processing

The ability to **quickly process** multiple pieces of information and **efficiently integrate** information under time pressure

Spatial Ability

The ability to **process visuo-spatial information** that is either static or dynamic

The aim of this assessment of cognitive abilities is to select applicants with an adequate cognitive basis to acquire the necessary skills during training and to ensure a homogenous level in the training courses. The tests are administered in a computer-based group testing with up to 50 applicants.

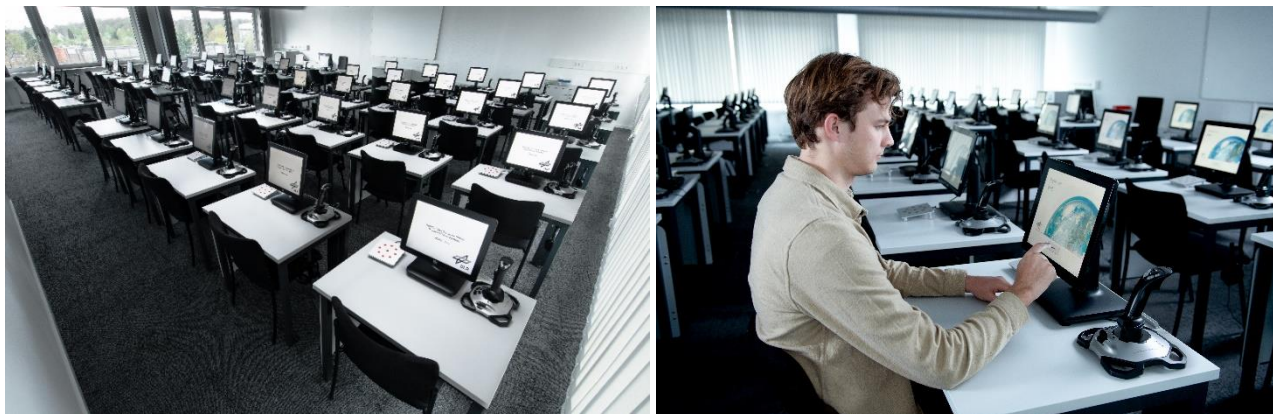Figure 3 Computer-based assessment of cognitive performance (Source: DLR, 2024)

Precision of Testing (Reliability)

Reliability is the precision of a measurement and can be assessed using Cronbach's alpha (α). For the cognitive performance tests, α ranged from .76 to .98. Thus, the **reliability of all cognitive performance tests** was confirmed and can be considered **good to excellent** according to scientific standards.

Work Sample Tests

The second selection phase consists of two work sample tests whose aim is to measure multitasking performance in simulations of ATCO working positions.

Dynamic Air Traffic Control Test

The Dynamic Air Traffic Control Test is a low-fidelity computer-based **simulation of an ATCO radar position**. It tests the ability to handle and monitor complex and dynamic situations. In three test runs, several aircraft have to be guided through a given airspace while acoustic tasks are solved in parallel.

Moreover, the test **mimics a coaching situation** similar to that in ATCO training: a test administrator assesses the applicant's behavior and provides feedback.

Figure 4 Introduction to the Dynamic Air Traffic Control Test (Source: DLR, 2024)

Figure 5 Strip Display Management Test (Source: DLR, 2024)

Strip Display Management Test

The Strip Display Management Test is a computerized test that **simulates air traffic management** based on digital flight strips.

For this test, applicants have to work with a digital flight strip board to assess, update, and order flight information. This information has to be evaluated and four **different types of tasks** are completed simultaneously.

Expert Decision

The decision to pass the second selection phase involves **trained selection experts** consisting of a DFS ATCO and a DLR psychologist. Performance in the Dynamic Air Traffic Control Test is rated by these experts. They then **integrate the results of both work sample tests** and decide whether an applicant fulfills the requirements of this selection phase according to predefined rules.

Assessment Center Team Exercises

The assessment center team exercises comprise two team exercises in which applicants' behavior is observed and evaluated by trained experts. Both exercises are used to assess social behavioral aspects and applicants' ability to work in a team.

Figure 6 Group Strip Exercise (Source: DLR, 2024)

Group Strip Exercise

In the Group Strip Exercise, a group of applicants must **work together to solve a task** with incomplete data on **simplified flight strips**.

The group is tasked with ordering the strips into complete flights and filling in the missing information based on the available data. Additionally, the group has to solve several secondary tasks.

Dyadic Cooperation Test

In the Dyadic Cooperation Test, two applicants have to **manage a computerized traffic control system**.

The task is to cooperatively allocate vehicles to roads while obeying rules and restrictions. The **limited timeframe** requires the efficient exchange of relevant information between the applicants which mirrors demands of the ATCO job.

Figure 7 Dyadic Cooperation Test (Source: DLR, 2024)

Aim of the Team Exercises

The results of the team exercises are used to
- **reject applicants** who showed **particularly low social competence** in the team exercises.
- **generate hypotheses to be explored in the selection interview** based on all observations and qualitative information gathered in the exercises.

English Proficiency

Both written and oral English proficiency are tested in the selection process. The written English test is administered in the first selection phase together with the cognitive performance tests. The oral English exam is conducted before the selection interview.

Written English Test

The written English test assesses **three types of written English proficiency**:

- Word comprehension and finding synonyms
- Completing sentences in correct grammar
- Understanding common phrases and finding corresponding synonyms
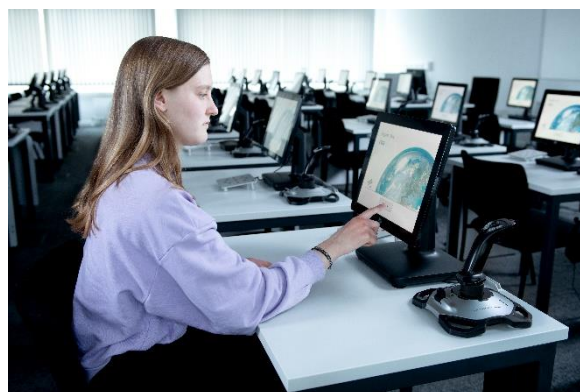
Figure 8 Written English test executed within the cognitive performance test battery (Source: DLR, 2024)

Figure 9 Oral English exam (Source: DLR, 2024)

Oral English Exam

The oral English exam is conducted by two trained DFS ATCOs and the **applicant's oral English skills** are assessed on the basis of grammar, pronunciation, and vocabulary.

Behavioral assessment in exam situations

During the oral English exam, the degree to which applicants and their performance are affected by the examination itself is assessed. **Visible stress symptoms** and **performance impediments** are noted and followed up on in the selection interview.

Selection Interview

The final phase of the DLR ATCO selection process is the selection interview which consists of several components: interviewing the applicant, conducting interactive problem-solving tasks, integrating the results from all selection phases, and finally providing the selection board's risk assessment and prognosis.

Figure 10 Interview with the selection board
(Source: DLR, 2024)

Semi-structured Interview

The selection interview is semi-structured and **focuses on the applicant's biography and motivation to become an ATCO**. Hypotheses from previous selection phases and selection information are addressed in the interview by a DLR psychologist.

The selection interview is a **synopsis** that integrates applicant's performances and selection information from the previous selection phases.

Generating Hypotheses for the Interview

In addition to the observations from the team exercises to help generate hypotheses, results of applicants' self-assessment **personality questionnaire** are incorporated. This DLR in-house questionnaire was specifically developed for the assessment of aerospace personnel and comprises 10 personality dimensions. According to psychological quality standards, **selection decisions are not solely based on results of a personality questionnaire**. Instead, the personality assessment complements the selection process to generate hypotheses for the interview.

Additionally, questions that arise from data of all previous selection phases may be **addressed in the selection interview for clarification**.

Interactive Proficiency

At the end of the selection interview, applicants are asked to work on several **interactive problem-solving tasks** supported by a DFS ATCO of the selection board as their coach.

Interactive proficiency assesses whether applicants are able to recall learned knowledge and skills to solve difficult tasks, to apply feedback immediately, and to interact efficiently with a coach under time constraints, that is, demonstrate **coachability**.

Figure 11 Assessment of Interactive proficiency by the selection board (Source: DLR, 2024)

Interview Risk Assessment and Prognosis

All information gathered throughout the **selection process is integrated by the selection board** after the interview. The board conducts a **comprehensive risk assessment** on the potential risk for ATCO training success. The selection interview is concluded with a **homogeneous overall ATCO career prognosis** by the selection board.

After informing applicants whether they have been recommended for ATCO training, they are **offered a feedback** on their performance in the selection process. Namely, unsuccessful applicants are given an overview of the reasons for not passing the selection and successful applicants can be advised on areas of further development in the training.
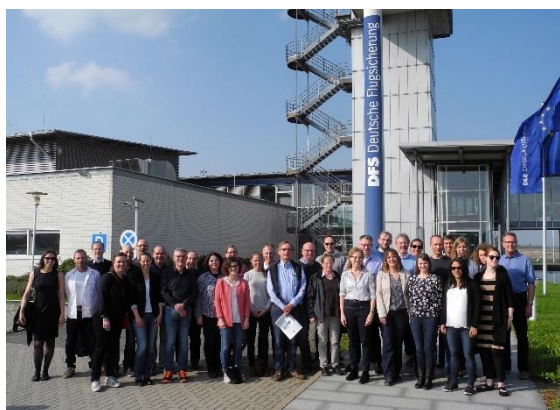
Figure 12 Selection board members consisting of DFS ATCOs and DLR psychologists (Source: DLR)

Selection Board

The selection interview is conducted by a selection board consisting of four members: **two DFS ATCOs and two DLR psychologists**.

All selection board members are **selected and carefully trained** and work with a standardized decision-making process. DFS DLR selection training takes place every year to exchange relevant information and take part in standardization exercises.

3. DFS ATCO Training

As training criteria to assess the predictive validity, the available DFS ATCO training information from both training phases was employed.

Training Structure

The contents and basic structure of ATCO training and licensing are governed by worldwide (International Civil Aviation Organization (ICAO), European (EU/European Commission)) and national regulations.

These standards define two phases of ab initio training: initial training (IT) and unit training (UT). DFS designed the second version of the DFS Air Traffic Management Training System (DATS 2) to accommodate these requirements. This validation study focused on the selection and training of ab initio trainees until they obtained their ATCO licenses and became certified ATCOs.
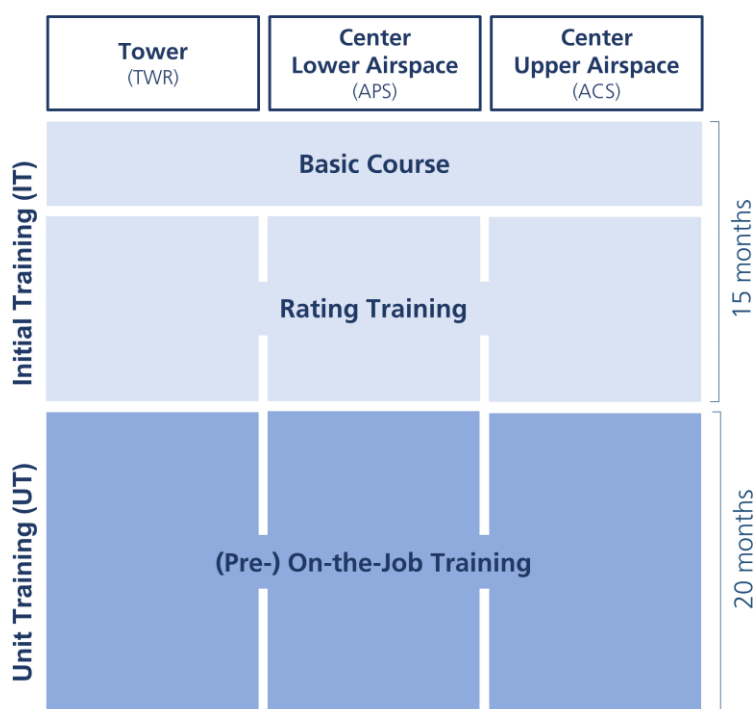
Figure 13 ATCO training structure with average durations from the validation study ($N = 603$ for IT, $N = 554$ for UT)

ATCO training is differentiated by work position, namely tower or center, and further divided into the center-specific work positions upper airspace (leading to an Area Control Surveillance Rating, ACS) and lower airspace (leading to an Approach Control Surveillance Rating, APS, with Terminal Control endorsement, TCL, according to EU licensing regulations). Thus, three different training structures exist: tower, center upper airspace, and center lower airspace.

For the validation analyses, the data of the three training structures were combined because of their general comparability in terms of the ATCO work, and their comparable training assessments.

Initial Training

The initial training takes place at the DFS Academy in Langen, Germany. ATCO training begins for all trainees with a basic course that aims to prepare for rating training with specific modules in which they obtain their student licenses. Note that the training structure described is that at the time of the validation study.

Basic Course

- Theoretical lessons tested in written exams
- Simulation-based lessons with one practical exam
- English proficiency tested in an oral English exam

Figure 14 Trainee with his coach during ATCO training (Source: DFS Deutsche Flugsicherung GmbH)

Rating Training

- Specific modules for tower and center
- Simulation-based training and theoretical lessons
- Theoretical performance assessed in 3–6 written exams
- Practical performance assessed in 2–3 phase reports graded on a set of 13 DATS criteria
- Licensing exams aimed at obtaining student licenses

IT Student Licenses

Tower

- Ground Control
- Radar for Separation
- Local Control

Center Lower Airspace (APS)

- Area Executive
- Approach Executive
- Area Planner

Center Upper Airspace (ACS)*

- Upper Area Executive
- Upper Area Planner

    * Some trainees obtained combined APS/ACS licenses due to former training structure

Changes of IT Courses

The IT course refers to the assigned training group of the ATCO trainees during their IT.

Only **3% of trainees** in the validation sample had to change their course during IT, while the others remained on the IT course to which they had been assigned when starting their training.

Initial Training Performance

Assessment data from all IT theoretical and practical exams were used to compile 10 performance criteria, in addition to the content-specific DATS criteria. In this project report, the results for the IT performance criteria are summarized as **initial training performance** (see chapter 6 on the prediction of training outcomes by selection).

Unit Training

After successfully completing initial training, trainees advance to unit training to learn on the job at a respective DFS tower or DFS center in Germany (or the center in Maastricht, Netherlands, at the time of the study). The aim of (pre) on-the-job training is for trainees to complete their training as certified ATCOs by obtaining the required ATCO licenses for their work position. Note that the training structure described is that at the time of the validation study.

On-the-Job Training

- After an introductory simulation, trainees work in their training-specific ATCO positions with live traffic under coach supervision and are assessed regularly on 13 performance dimensions similar to the DATS performance criteria in IT (see dimensions below).
- In addition, to support validation, DFS coaches or, in some cases, informed DFS employees assess the trainees' performance on a final validation questionnaire on these 13 performance dimensions and three overall rating dimensions at the end of UT (Behavioral Observation Scales, BOS).

BOS Dimensions

1. Theory
2. Radiotelephony/ Coordination Procedures
3. Communication
4. Strip Handling
5. Situational Awareness
6. Problem Recognition
7. Traffic Planning
8. Reaction
9. Separation/Ground Control
10. Customer Orientation
11. Ability to Cope under Pressure
12. Teamwork
13. Manner and Motivation*

- Overall Performance
- Attitude and Behavior
- Required Duration

    * later introduced during validation time period

Figure 15 Trainee during ATCO training (Source: DFS Deutsche Flugsicherung GmbH)

Changes of UT Units

Only **1% of trainees** in the validation sample had to change their unit during UT, while the others remained at their DFS unit to which they had been assigned when starting their on-the-job training.

Unit Training Performance

Coach ratings on the content-specific BOS dimensions of the validation questionnaire were used to compile one overall UT performance criterion, in addition to the content-specific BOS dimensions. Moreover, the BOS overall performance rating was used as a criterion for UT performance. In this project report, the results for the UT performance criteria are summarized as **unit training performance** (see chapter 6 on the prediction of training outcomes by selection).

4. Key Features of the Study

The key features of this validation study are the validation sample size, the extensive additional analyses of selection data, and the availability of additional training data.

This study encompasses the largest **validation sample of *N* = 603 applicants** recommended for ATCO training among DLR studies to date. Furthermore, a **reference sample of *N* = 13,133** applicants was used with all applicants tested by DLR in approximately the same selection period. Furthermore, this study differs from previous DLR validation studies in terms of additional analyses of applicants' biographical information and in-depth analyses of the selection interview process.

Key Features of the Validation Study

- Largest DLR validation sample size

- Additional analyses of applicants' biographical information

- In-depth analyses of the selection interview process

- Availability of detailed performance assessments from DFS unit training beyond pass/fail

These additional biographical analyses reveal interesting insights into specific biographical and educational aspects of successful applicants before their ATCO application, their vocational motivation for applying, and their potential job alternatives. With regard to the selection process, additional data on the interview risk assessment by the selection board members and their reasons for identified risks were processed to provide insights into the decision process of the selection board.

Key Aspects of Data: Biographical and Selection Information

- Applicants' high school education

- Applicants' potential post-high school education

- Motivational aspects for ATCO application

- Applicants' alternative job interests

- Interview risk assessment and reasons for identified risks

- Developmental advice after the recommendation

In terms of training, this is the first time that detailed performance data from the unit training, that is, supervised training on live traffic at the assigned DFS tower or center, based on a coach-rated validation questionnaire were available (see p. 16). Thus, the results of the study reveal new insights into selection and training performance.

5. Approach and Challenges

This validation study was based on a validation sample and a reference sample. Elaborate data preparation was conducted before the performance of statistical analyses. As with every validation study a number of challenges also have to be considered in this study.

Approach of this Study

The validation sample refers to a sample of applicants that successfully completed the DLR selection process and started DFS ATCO training, whereas the reference sample refers to applicants who participated, most of which unsuccessfully, in the DLR selection process at approximately the same time.

	Validation Sample	Reference Sample
Sample Size	603	13,133
Applicants	100% recommended	6% recommended
Gender	72% male, 28% female	60% male, 40% female
Age	Mean of 20 years (18–25 years)	Mean of 20 years (17–26 years)
Selection	Nov 2008 – May 2013	Nov 2008 – Feb 2014
Training	Jan 2010 – Sept 2018	–

Table 1 Description of validation and reference samples.
Note that the time period of both samples cannot be fully aligned due to the multiphase selection process and, thus, the numbers of both samples cannot be set off against each other.

For the validation sample, comprehensive quantitative and qualitative DLR selection data and biographical information of the applicants were used. Extensive training data on the trainees' performance and success (i.e., pass/fail) in ATCO training were provided by DFS.

Data Preparation/Processing

- Coding and categorization of qualitative information into quantitative data, i.e., biographical and additional selection information

- Merging of DLR selection data and DFS training data

- Data plausibility and quality checks

- Data aggregation of selection predictors and training criteria

A considerable amount of qualitative applicant data was gained from a biographical questionnaire and selection interview documentation. These qualitative data were coded into quantitative data and categorized.

All DLR selection data and DFS training data were merged into a final data set and checked for plausibility and quality. Due to the large number of variables in the validation data set, aggregation was used to combine variables based on their content for selection predictors and training criteria.

Statistical Analyses

- Final validation data set with ~900 selection and training variables

- Largest available sample sizes for each analysis

- Correlation analyses, regression analyses, and if appropriate, chi-squared tests

For each statistical analysis, the largest available sample size was used. For most of the analyses, the sample sizes were smaller than $N = 603$ or $N = 13{,}133$. The reasons for the smaller sample sizes were subgroup analyses and/or missing data, i.e., data were not available. Changes in the selection procedure and the training structure during the collection of the validation data resulted in slightly different data for subgroups of applicants.

Challenges of Validation Studies

A validation study poses several methodological challenges that impact data collection, data analysis, and the interpretation of results. One of the most relevant challenges is the long time span of validation studies.

Challenges of Validation Studies: Long Time Span

- Long time span between availability of selection data and corresponding training data

- Availability of relevant training data only after completion of training

- Collection of training data at multiple sites/units

- Changes in selection and training structures over time

- Studies with comprehensive training data cannot provide contemporary analyses

Compiling a validation sample is challenging because of the time span necessary to obtain a sufficient sample size with selection data and training data (including pass/fail) for the same applicants/trainees. Thus, only selection and training data of trainees who finished their training (either successfully or unsuccessfully) can be included in the validation sample.

This requirement leads to a prolonged data collection period in validation studies, during which changes can occur in selection and training. Therefore, the validation sample was chosen to encompass a homogeneous DLR selection procedure and DFS training structure with as few changes as possible.

A major methodological challenge in the interpretation of the results is the restricted variance in predictors and criteria.

Challenges of Validation Studies: Variance Restriction

- **Variance restriction in selection predictors**
  No selection data for applicants who did not pass the selection (phases)

- Thus, the variance of selection predictors is **particularly affected by restriction in selection processes** with **low selection rates**

- **Variance restriction in training criteria**
  No training data of unsuccessful trainees for later training phases

- **Consequence for statistical analyses**
  Meaningful effects might not be identified by statistical analysis and strengths of correlations are underestimated.

The variance restriction in selection predictors is especially relevant due to the low selection rate. Only 6% of applicants who entered the DLR selection in the validation period were recommended for ATCO training after the final selection phase, leading to a considerable amount of unavailable selection data.

In addition, variance restriction also occurs in the training criteria, as can be seen from the success rates. The training success rate for the trainees in the validation sample was 70%, that is, the ratio of those who finished training and became fully validated ATCOs in their assigned training affiliation (tower, center lower airspace, center upper airspace) to the total number of trainees who initially started IT. The success rate varied across the training affiliations. Among all the trainees, 92% passed the IT.

Although the IT pass rate can be seen as a more than satisfactory result given the high levels of traffic and complexity used in the simulations at the DFS Academy, including military procedures, the overall success rate in the period analyzed was slightly lower than that in past studies. Due to the variations in the success rates across the specific DFS units, adaptions in the training structure and the intersection between IT and UT were made to address this issue which led to increased success rates in the years after the study period.

6. Prediction of Training Outcomes from Selection

DLR Selection

DFS ATCO Training

Predictive Validity

Figure 16 Illustration of the validation analyses for the prediction of DFS ATCO training outcomes from DLR selection (Source left photos: DLR, 2024; source right photos: DFS Deutsche Flugsicherung GmbH)

Selection Predictors

- **Cognitive Performance**
- **Work Sample Performance**
- **Team Exercise Performance**
- **Selection Interview Assessment**

- **English Proficiency**

Note. For a detailed description see chapter 2

Training Criteria

- **Initial Training Performance**
- **Unit Training Performance**
- **Overall Training Pass/Fail**

- **Initial Training English Exam**

Note. For a detailed description see chapter 3

Legend for Validation Tables

Summary of significant and systematic results for each selection phase

- ✓ Predictive of training performance or pass/fail in the expected direction, i.e. better selection performance was associated with better training performance or a higher likelihood of passing overall training

- (✓) Predictive of training performance or pass/fail in the unexpected direction, i.e. better selection performance was associated with lower training performance or a lower likelihood of passing overall training

Interpretation of validation results

- Validation analyses were based solely on applicants who succeeded in the selection and started the ATCO training

- Results showing no predictive validity might be due to variance restriction and do not automatically imply that a test is not a useful component of the selection procedure

Note. Summary of significant and systematic results for each selection phase based on several predictors and performance criteria or pass/fail

Cognitive Performance

Cognitive performance was statistically associated with initial training performance (see Table 2).

This means that better cognitive performance in the selection was related to better performance of the trainees in the initial training phase.

No systematic associations were found between cognitive performance and unit training performance or overall training pass/fail.

Figure 17 Cognitive performance test (Source: DLR, 2024)

Predictive Validity of Cognitive Performance

	Initial Training Performance	Unit Training Performance	Overall Training Pass / Fail
Cognitive Performance	✓		

Table 2 Summary of validation results for cognitive performance (see explanation on p. 21 and pp. 15–16)

Relevance of Cognitive Domains

- Memory, speed of processing, spatial ability, and attention were associated either with IT performance and/or IT pass/fail, with **memory** and **speed of processing** showing the **most systematic associations.**

- Thus, better performance in these cognitive domains in the selection was related to either better performance in initial training and/or a higher likelihood of passing initial training.

Conclusion

- Cognitive performance tests that assess the basic cognitive abilities and skills relevant for ATCO training appear to be especially **predictive of initial training performance**.

- This finding is in line with trainees having to acquire **extensive theoretical ATCO knowledge** and **practical skills in simulations** in initial training to obtain the basis for unit training on live traffic.

- Cognitive skills are **particularly beneficial for acquiring the theoretical basis** in this early training phase. The necessary level of cognitive abilities appears to be tested in the selection.

Work Sample Performance

Figure 18 Work sample test (Source: DLR 2024)

Work sample performance was statistically associated with initial training performance, unit training performance, and overall training pass/fail (see Table 3).

This finding means that better work sample performance in the selection was related to better performance of the trainees in the initial training and unit training.

Moreover, trainees with higher work sample performance were more likely to pass ATCO training successfully.

Predictive Validity of Work Sample Performance			
	Initial Training	**Unit Training**	**Overall Training**
	Performance	**Performance**	**Pass / Fail**
Work Sample Performance	✓	✓	✓

Table 3 Summary of validation results for work sample performance (see explanation on pp. 15–16 and p. 21)

Conclusion

- As expected, the work sample performance appears to **predict training performance** in both initial training and unit training and overall training success.

- This finding is in line with an essential role of **multitasking abilities** for training performance in **simulations and live traffic** alike.

- Thus, the results underline the **importance of using complex simulations in the selection** to evaluate the applicants' multitasking abilities.

Team Exercise Assessment

Predictive Validity of Team Exercise Assessment

- Team exercise assessment **did not show** systematic **associations with training criteria**.

- However, **team exercise assessment** showed **predictive validity for interview success** and thus, recommendation for training.

- Thus, this means better team exercise assessment was related to a higher likelihood of passing the selection interview and recommendation for ATCO training.

Figure 19 Team exercise (Source: DLR, 2024)

Conclusion

- **The lack of predictive validity of the team exercise assessment** does not imply that it does not contribute to the prediction of training outcomes.

- Team exercises are **important for rejecting applicants with clearly inappropriate team performance** who were therefore not part of the validation sample.

- Observations from the team exercises are **further explored in the selection interview**.

- Information from the team exercises is **included in the risk assessment** of the interview and, thus, might **contribute to the validity of the interview**.

English Proficiency

Predictive Validity of English Proficiency

- Applicants' **English proficiency in the selection** was associated with their training performance in the **IT English exam**.

- This means better English performance during selection was related to better English performance in the English exam of the initial training.

- Thus, **English proficiency** in the selection was **predictive** of **English training performance**.

Figure 20 Oral English exam (Source: DLR, 2024)

Selection Interview Assessment

Figure 21 Interview (Source: DLR, 2024)

The selection interview assessment was statistically associated with initial training performance, unit training performance, and overall training pass/fail (see Table 4).

Thus, a better selection interview assessment was related to better performance of the trainees in the initial training and unit training. Moreover, trainees who received a better selection interview assessment were more likely to pass ATCO training successfully.

Predictive Validity of Interview Assessment

	Initial Training	Unit Training	Overall Training
	Performance	Performance	Pass / Fail
Interview Assessment	✓	✓	✓

Table 4 Summary of validation results for selection interview assessment (see explanation on p. 21 and pp. 15–16)
Note. Results for selection interview are based on several risk assessment predictors as well as prognosis rating predictors.

Moreover, the in-depth analyses of the interview content (e.g., vocational motivation aspects) and the decision process of the selection board (e.g., reasons for identified risks) provided increased insight into the work of the selection board and formed a comprehensive basis to further refine the selection interview.

Conclusion

- The selection interview assessment, which is designed as a **synopsis** that integrates all information gathered throughout the selection process, is **predictive of training performance** and, most importantly, of **successfully passing the ATCO training** to work as a fully certified ATCO.

- As expected, the interview assessment showed **predictive validity of** the trainees' performance in **on-the-job training with live traffic**, which is very **similar to the actual work as a licensed ATCO**.

- With regard to the risk assessment of the selection board, the **general motivation** in different areas of the applicant's life appeared to be especially relevant for training outcomes.

- These findings confirm that the selection board **applies comparable criteria** and **appropriately integrates the information from the selection process** into a valid prognosis.

7. Biographical Aspects and Predictions of Training Outcomes

The categorized biographical information provided a comprehensive and detailed insight into the high school education and post-high school education of successful applicants, namely those who started ATCO training.

To understand the role of the applicants' high school education, we investigated the predictive validity of the following biographical aspects of high school education in the validation sample:

High School Education

Of the **successful applicants** who started ATCO training in the validation sample:

- **Final Grade**
  Average final grade of 2,2 for high school graduation

- **School Year Repetition**
  9% had repeated at least one school year

- **Advanced Math Course**
  41% had taken an advanced course in math

- **Advanced Physics Course**
  16% had taken an advanced course in physics

- **Advanced English Course**
  42% had taken an advanced course in English

Source: Pixlr AI-generated, 2024

Note. Sample sizes N = 583–603, n = 4–20 missing

The validation results showed which of the biographical aspects of high school education (if any) were predictive of ATCO training in the validation sample:

Predictive Validity of High School Education

- **Final grade and school year repetition** in the applicants' high school education were **predictive of training outcomes**, whereas other biographical predictors were less relevant.

- This means that applicants with **better final grades and who did not repeat a school year** showed **better training performance** and tended to be more likely to pass training.

- Taking an **advanced course in math, physics or English** appeared to be **neither advantageous nor disadvantageous** for ATCO training outcomes.

Note. Summary of significant results for each biographical aspect based on several performance criteria and pass/fail

To understand the role of the applicants' potential post-high school education before their ATCO application, we investigated the predictive validity of the following biographical aspects of post-high school education in the validation sample:

Post-High School Education

Source: DALL-E AI-generated, 2024

Of the **successful applicants** who started ATCO training in the validation sample ($N = 603$):

- **32% had post-high school education** (studies or apprenticeship) before their ATCO application

  Details of those applicants ($N = 174–191$):

  - **Duration**
    On average, almost 2 years (22 months) was spent in another post-high school education before their ATCO application

  - **Graduation**
    24% of those applicants had already graduated academic studies or an apprenticeship with a degree

  - **Change**
    19% of those applicants had changed from one completed academic studies or apprenticeship to another

  - **Dropout**
    34% of those applicants had dropped out of their academic studies or apprenticeships at least once

Note. Results are based on what the applicants reported. Details on post-high school education: $n = 0–17$ missing. $N = 412$ had no previous post-high school education.

The validation results showed which of the biographical aspects of post-high school education (if any) were predictive of ATCO training in the validation sample:

Predictive Validity of Post-High School Education

- Aspects of **post-high school education lacked predictivity** of ATCO training outcomes except for dropout

- **Dropping out of a post-high school education** was associated with **better performance** in unit training

- Overall, having a **post-high school education** before the DFS ATCO application appeared to be **neither advantageous nor disadvantageous**

Note. Summary of significant results for each biographical aspect based on several performance criteria and pass/fail

To understand the role of the applicants' demographics, we investigated the predictive validity of both age and gender in the validation sample. Note that age and gender were **not included in the psychological assessment** of DLR selection or considered in the final selection decision.

Age and Gender

For **successful applicants** who started ATCO training in the validation sample:

- **Age**
  Mean of 20 years (18–25 years) with more than 50% aged 18 or 19 years

- **Gender**
  72% male and 28% female

Source: DFS

Note. N = 603. Note that since the validation period, "diverse" was added as gender category.

The validation results showed which of the two demographic aspects (if any) were predictive of ATCO training in the validation sample:

Predictive Validity of Age and Gender

- **Younger applicants** tended to perform **better in training** and were more likely to pass ATCO training successfully.

- **Female trainees** tended to perform **better in training**. However, gender-related performance differences in training did not significantly affect the likelihood of passing training successfully.

Note. Summary of significant results for each biographical aspect based on several performance criteria and pass/fail

Overall Conclusion for Biographical Aspects

- **High school education, age, and gender** were **predictive** of ATCO training outcomes.

- **Focusing** explicitly **on recruiting applicants with prior post-high school education** and/or graduation from post-high school education with a degree appears to be **neither advantageous nor disadvantageous** (apart from the reported relations of age and training outcomes).

- Considering applicants' **biographical information on previous education** is an **essential part in the selection process** and the applicants' biographical information is considered thoroughly in the selection interview.

8. Prediction of Unit Training Outcomes from Initial Training Outcomes

In addition to examining the prediction of training outcomes from selection and biographical aspects, this validation study investigated whether trainees' performance in the early training phases was predictive of their performance in the later training phase at their respective DFS units.

Figure 22 Illustration of the validation analyses for the initial training outcomes on the subsequent unit training outcomes (Source: DFS Deutsche Flugsicherung GmbH)

Predictive Validity of Initial Training for Unit Training

- **Trainees' performance during the initial training** at the DFS Academy was **predictive** of their later **unit training performance** at the tower/center.

- Trainees' performance in the **theoretical and, in particular, practical parts** of initial training were **predictive** of their later unit training performance.

- Trainees' performance in both the **basic course and rating training** (including licensing) of initial training was **predictive** of their later unit training performance.

Note. Summary of significant results for Initial/Unit Training performance based on several performance criteria

Conclusion

- **Practical performance aspects** of initial training were **particularly relevant** for predicting performance in unit training.

- While the theoretical aspects of initial training provide the essential foundation, the **practical application** of the theory is **pivotal for progression in training.**

- The findings emphasize the **important role of practical training during initial training** as part of the overall training trajectory.

- **Initial training covers essential training** to prepare trainees for unit training.

9. Overall Conclusion and Implications

Overall Conclusion

- **The predictive validity** of the **DLR selection procedure** for the **DFS ATCO training** was **confirmed.**

- For the first time, more detailed data on **ATCO unit training performance** were **available** and the UT training performance **could be predicted from the selection procedure.**

- **High school education, age, and gender** were **predictive** of ATCO training outcomes, whereas **prior post-high school education** appeared to be **neither advantageous nor disadvantageous** for ATCO training outcomes.

- Additionally, the study provides novel insights into the relevance of **applicants' education** and in-depth analyses of the **selection interview and decision-making** process.

- **The predictive validity** of ATCO **initial training** for ATCO **unit training** was **confirmed.**

Validation studies are impeded by a number of methodological challenges and limitations, for example, variance restriction in the predictors and criteria. Despite these challenges, the results of this validation study corroborate the predictive quality of the selection process.

However, it is important to note that even results for selection instruments showing no predictive validity do not automatically imply that this instrument is not a useful component of the selection procedure.

Finally, the results of this validation study enable a continuous optimization of selection and training. The following implications to further optimize DLR selection were deduced:

Implications for Selection

- Adapt **selection rules and/or guidelines**, e.g., for work samples and interview

- Further enhance the **efficiency of the selection process**, such as by adapting or removing cognitive tests

- Present **validation results** and their implications to **members of the selection board** for integration into their future selection work

- Increase **automation in the selection process**, such as by using the information from the interview to automate reports

Source: DLR, 2024

In addition to the already implemented adaptations of the selection process, the validation results provide a comprehensive basis for potential reasonable adaptations in the future. Overall, the measures to optimize the DLR selection process will refine a process that is already highly optimized due to regular evaluations and improvements over the previous years.

Concerning the implications for the DFS ATCO training, this study provided valuable information based on the predictions of training outcomes from selection and, in particular, on the prediction of unit training outcomes from initial training outcomes. The following implications to further optimize DFS ATCO training were deduced:

Source: DFS Deutsche Flugsicherung GmbH

Implications for ATCO Training

- Provide **additional support** in IT **for trainees**

  - with **pronounced performance issues** in the early training phase

  - with **training difficulties in simulations**

  - specifically based on **previous educational information**

- Enhance **differentiation of coach ratings** in IT simulations

  - e.g., by using the entire rating scale to assess trainees' performance and by rating specific performance on content-specific dimensions

- Maintain **use of validation questionnaire** for UT

  - Increase **comparability** of ratings, for example, ratings only given by **coaches who supervised trainees** for a longer time period

In this way, training of ab initio ATCOs could be facilitated, and the quality of the data for future validation analyses can be further enhanced.

In addition to implications for selection and training, the validation results provide relevant information for DFS stakeholders, such as ATCO training, marketing, and recruitment departments.

Additional Implications for DFS

- Present **validation study to DFS stakeholders**

- **Clarify** potential **assumptions** about the selection

- Further tailor **marketing and/or recruitment strategies** based on detailed biographical information of applicants

Outlook

- In addition to validation studies, **research on the impact of future ATM systems and procedures** can provide a basis for identifying future ATCO requirements.

- **Requirements of ATCO work** can shift due to technical developments such as automated systems and collaboration with artificial intelligence.

- **Adapting the selection process** with new selection tests or innovative approaches is an important step toward measuring required future ATCO competencies.

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A

ACS ....Area Control Surveillance
APS ....Approach Control Surveillance
ATCO .... Air traffic controller
ATM ....Air traffic management

B

BOS...Behavioral Observation Scales

D

DATS.. DFS Air Traffic Training System
DFS ....Deutsche Flugsicherung GmbH
DLR ....German Aerospace Center

I

ICAO ....International Civil Aviation Organization
IT .... Initial training

O

OJT ....On-the-job training

R

RTF...Radio Telephony Coordination Procedures

T

TCL ....Terminal Control

U

UT.. Unit training