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Validation of Computerised Aptitude Selection System (Compass) In Predicting Success of Uav Applicants in the Republic of Singapore Air Force (Rsaf)

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VALIDATION OF COMPUTERISED APTITUDE SELECTION SYSTEM (COMPASS) IN PREDICTING SUCCESS OF UAV APPLICANTS IN THE REPUBLIC OF SINGAPORE AIR FORCE (RSAF)

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The study examined the predictive validity of the Computerised Aptitude Selection System (COMPASS) that was set up to support the RSAF in its selection of pilots and other vocations. COMPASS measures cognitive abilities theoretically identified to be relevant to the vocation and was introduced for Unmanned Aerial Vehicle (UAV) pilot selection since 2003. With fast changing technological advancement of the UAVs, it is important that validation studies are regularly conducted to improve the effectiveness of the test suite in predicting training success. 219 UAV Pilot applicants' COMPASS scores were analysed against their actual training outcomes to determine a theoretically and statistically sound selection composite. Hierarchical multiple regression was done, and findings revealed that the current composite of tests remained to be significantly correlated with applicant success in UAV pilot training. The paper discusses the practical considerations in streamlining the tests to be included in the final assessment composite. Future studies should consider exploring non-cognitive assessment to improve the predictive validity of the overall selection system beyond COMPASS.

The UAV has evolved to play an increasingly critical role in modern warfare, with capabilities in tasks such as air intelligence, surveillance and reconnaissance. With increasing complexity of UAV operations that comes along with technological advancement, there is a need to study the ideal profile of a new generation of UAV operators. In addition, there is a need to ensure that existing selection systems continue to identify the appropriate abilities and traits expected in applicants to ensure the greatest likelihood of training success. This is particularly important, given the amount of resources invested in UAV pilot training, such as infrastructure support, aircraft maintenance, and highly-trained instructors. It is pertinent to develop a strong selection battery to identify candidates with higher potential of meeting the training criteria to improve overall organisational effectiveness (Carretta & Ree, 2003) and training efficiency.

Cognitive assessments are considered the gold standard in employee selection and assessment. They have been found to have comparable or better predictive validity over other selection tools (Schmidt & Hunter, 1998). The selection process for assessing UAV pilot applicants in the Republic of Singapore Air Force (RSAF) is multi-tiered and is comparable with established Air Forces around the world and has improved training efficiency and success for the RSAF. COMPASS forms one part of a four-stage selection process for applicants and is focused on assessing cognitive traits identified to be critical to UAV training success.

While the predictive validity of the selection composite for UAV pilots has remained largely stable in recent years, it is imperative for selection and training pipelines to pre-emptively evolve to meet shifting operational role of the platform. In anticipation of these changes, the RSAF selection system should be examined and reviewed to ensure that present assessment criterion continue to select candidates who are both willing and able to handle the demands of operating in a radically new operational environment.

The aim of the current study was to assess the predictive validity of the present cognitive assessment criterion based on the current operational environment and training demands. In addition, the study attempted to review and streamline the criterion for aptitudes that might no longer be relevant.

Methodology

Participants and Data

COMPASS and performance data of 219 UAV Pilot trainees from UAV Training School were examined for this analysis. The majority of the trainees were males, and their average age was 20.4 (SD = 2.1). COMPASS was administered at the point of candidate's application and the sub tests of COMPASS served as predictor variables for the criterion: trainees' performance data from UAV Training School. Regression analyses and Pearson correlations were used to determine best predictors of performance.

Procedure

The COMPASS test scores for the sample of UAV pilot candidates accepted into training were individually correlated with their end-of-course training results to determine the direction and strength between them. Tests that were significantly correlated and deemed to be measuring relevant abilities were entered into a hierarchical multiple regression model and the best-fit regression model was selected. The COMPASS composite score is therefore a weighted sum of the selected subtest scores. A multiple regression approach was adopted for two reasons. First, it allows for the tracking of performance of each predictor against the criterion defined, allowing for the determination and refinement of the selection composite. Second, it fits the recruitment requirements by allowing for the development of expectancy tables for HR and decision makers to easily understand candidate's probability of success in training (Tippins, Sackett, & Oswalkd, 2018).

Validation Methodology

Data cleaning and validation sample. Univariate descriptive statistics were obtained from the raw data. Repeated, missing, or outlying values were removed accordingly. Listwise deletion was also used to manage missing data. The spread of scores, skewness, kurtosis were checked to ensure normality. Skewness exceeding +/- 1 and kurtosis exceeding +/- 3 was considered unacceptable (George & Mallery, 2010). Checks were done on the validation sample to ensure the sample had the complete set of predictors (COMPASS score) and criterion data (end of course data).

Correlation and Regression. A correlation analysis was run with COMPASS test scores and training outcomes to determine the direction and strength between them. Tests that were significantly correlated and deemed to be measuring relevant abilities were identified. Subsequently, hierarchical multiple regression was run between the identified predictors and the criterion. Different combinations of multiple regressions were done to maximize the predictability of the composite scores.

Checks on statistical assumptions such as cases-to-Independent Variable ratio, multi-collinearity, and singularity among the Independent Variables were conducted. When determining the best regression equation, the following were considered: content validity of the test battery based on previous job analyses, correlation of individual tests with training outcome (r), low inter-correlations and high incremental validity (R^2 value), parsimony, stability of composite, accuracy of prediction, and distribution of applicant population that ensures a large enough selection pool.

Results

Correlation. Results show that all three tests of the current COMPASS selection composite remained moderately and significantly correlated to UAV training success (Cohen, 1988). The following test were identified to be entered based on their correlation with training outcome as well as the relevance to the training. The correlations are shown in Table 1.

Table 1.
COMPASS Tests with Significant Correlations with Training Success.

COMPASS Test Name	Ability Assessed	Correlations (r) with Success in UAV Training
SpatialO1	Estimation and spatial orientation	.31**
SpatialV1	Spatial Visualisation	.32**
MultiTask2	Multi-tasking test between psychomotor and auditory/mathematical processing	.25**

Note. ** indicates significance at $p < .01$.

Regression. Results from the hierarchical multiple regression show that the best-fit regression model was found to have a predictive validity, $R^2 = .39$. The three tests within the current model were retained within the proposed model, and their weightages were recalibrated based on the present validation analysis to form the proposed COMPASS selection composite. The regression equations are as shown in Table 2 below. Additional considerations in selecting the predictors include practical implications on the selection systems. This will be elaborated on in the *Discussion* section.

Table 2.
Current and Proposed Selection Composite.

	UAV Selection Composite	Correlations (R^2) with UAV Pilot Training Success
Current	Current Composite (SpatialO1 + SpatialV1 + MultiTask2)	.40** (N = 121)
Proposed	Retain Current Composite with Recalibrated Weights (SpatialO1 + SpatialV1 + MultiTask2)	.39** (N = 219)

Note. ** indicates significance at $p < .01$.

Discussion

In personnel selection, predictive validation tests for the inferences made during selection, especially if the inferences are not directly observable (e.g., psychological constructs) (Gatewood, Field, & Barrick, 2019). There needs to be balance between the strength of the intended validity inference and the practical limitations (Tippins, Sackett, & Oswalkd, 2018). As such, regular efforts are taken to consistently monitor the validity of the cognitive-test battery, and to further refine the COMPASS selection composite. In developing a selection composite, there were two key considerations. First, the selection composite should be able to reliably predict training outcomes. The composite score and the probability of success should also be positively correlated, such that a candidate's composite score increases vis-à-vis their probability of success at training. Second, the selection composite should be able to select sufficient pilots to meet pilot production demands. While developing a predictive composite, there is a need to balance this with practical consideration such that the supply pool continues to be sufficient to meet production targets.

One dilemma faced in determining the UAV selection composite was the difficulty in selecting between tests that were comparative in their statistical validity. In such cases, the face validity of tests was prioritised. For example, during initial analyses, multiple tests of multi-tasking in the COMPASS test battery were found to be significantly correlated to applicant training outcomes. In streamlining the tests to be included in the final assessment composite, the most demanding version of the Multi-tasking test was selected (MultiTask2), as it was determined that the test was more reflective of the high demands and complexity of UAV operations.

It was also noted that despite changes in operations and training in recent years, the predictive validity of the existing COMPASS composite has continued to be stable since its last validation in 2014. This finding suggests that the cognitive traits assessed by COMPASS continue to be essential despite advancements in technology and changes in operational requirements.

Nevertheless, it is clear that with the introduction of new work demands and the increasing complexity of UAV systems, there may be a need to supplement the COMPASS selection system with additional tests that measure relevant traits beyond the fundamental cognitive traits. This includes tests that assess soft skills and other non-cognitive traits that have been found to be related to UAV training success. One example would be the inclusion of personality testing as part of the overall selection composite. Studies examining the relationship between the Big Five personality traits and UAV training performance have suggested that Agreeableness, Extroversion and Conscientiousness are positively associated with UAV training success (Barron et al., 2016). To improve the predictive validity of the overall selection system beyond COMPASS, the introduction of such testing is essential.

The next generation of aptitude selection tests should incorporate the gaps (such as critical thinking) and also review testing methodology to also provide a realistic job performance preview to assessors, as well as to entice the right people for the job.

Conclusion

The reviewed COMPASS selection composite suggests that the RSAF continues to employ aptitude selection tools of good predictive validity for the recruitment of UAV Pilots. This allows for downstream benefits in optimising the production pipeline and deployment of UAV pilots.

References

Barron, L. G., Caretta, T. R., & Rose, M.R (2016). Aptitude and Trait Predictors of Manned and Unmanned Aircraft Pilot Job Performance. *Military Psychology 28(2), 65-77.*

Carretta, T. R. & Ree, M. J. (2003). Pilot selection methods In: *Human factors in transportation: Principles and Practices of Aviation Psychology* (seriesed. B. H. Kantowitz, vol. eds T. S. Tsang and M. A. Vidulich), pp.357–396. Erlbaum.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences. (2nd ed.). Hillsdale, Erlbaum Associates.

Gatewood, R. D., Field, H. S., & Barrick, M. R. (2019). Human resource selection. Mason, Ohio: Thomson/South-Western.

George, D., & Mallery, M. (2010). *SPSS for Windows Step by Step: A Simple Guide and* Reference, 17.0 Update (10th ed.). Boston, USA: Allyn & Bacon.

Schmidt, F. L., & Hunter, J. E. (1998). The validity and utility of selection methods in personnel psychology: Practical and theoretical implications of 85 years of research findings. *Psychological Bulletin, 124(2)*, 262-274.

Schmidt, F. L., Hunter, J.E., & Outerbridge, A. N. (1986). Impact of job experience and ability on job knowledge, work sample performance, and supervisory ratings of work performance. *Journal of Applied Psychology, 71*, 432-439.

Steiner, D.D & Gilliland, S.W. (1996). Fairness reactions to personnel selection techniques in France and the United States. *Journal of Applied Psychology, 61 (1006),* 134-141.

Tippins, N., Sackett, P., & Oswalk, F. (2018). Principles for the validation and use of personnel selection procedures. *Industrial and Organizational Psychology, 11 (S1)*, 1-97.

Wheatcroft, J.M., Jump, M., Breckell, A.L., & Adams-White, J. (2017). Unmanned aerial systems (UAS) operators' accuracy and confidence of decisions: Professional pilots or video game players? *Cogent Psychology*, *4*(1).