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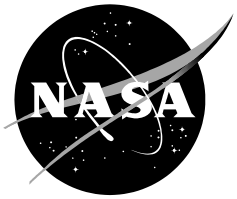

Investigating the Relationship Between Personality Traits and Astronaut Career Performance: Retrospective Analysis of Personality Data Collected 1989-1995

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For:
Behavioral Health and Performance (BHP) Research Element
NASA Human Research Program

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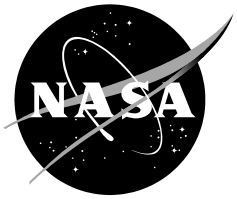

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Contents

Acronyms

BHP	Behavioral Health and Performance
EPAQ	Extended Personal Attributes Questionnaire
EVA	extravehicular activity
JAS	Jenkins Activity Survey
NEO-FFI	NEO-Five Factor Inventory
PAQ	Personal Attributes Questionnaire
PRF	Personality Research Form
WOFO	Work and Family Orientation Questionnaire

1. Overview

This report presents an analysis of an existing astronaut psychological trait dataset and the relationship between those data and publicly available metrics of astronaut career performance. This project is funded by a contractual agreement between the author and the Behavioral Health and Performance (BHP) Research Element at EASI/Wyle and NASA. This work was undertaken for the purpose of informing future selection strategies for astronaut applicants, and to create a better understanding of the relationship between individual psychological characteristics and the job of being an astronaut. As per long-standing agreements between participants and the investigators who collected these data, no direct sharing of any data that may be individually identifiable shall be made between the author of this report and NASA or any of its agencies.

2. Understanding the Personal Characteristics Data Set

This investigation of the relationship between astronaut personal characteristics and astronaut career performance involves the reassembly and analysis of two archived datasets. Two distinct sets of data were collected between 1989 and 1995. The first of these was derived from the original study of astronaut personality and performance conducted by Helmreich, Rose, et al. – begun in 1988 with results published in 1993 and 1994 (Rose, Fogg, Helmreich, & McFadden, 1994). A part of this original study involved the psychological testing of the population of 65 active-duty NASA astronauts in 1989. Of the 89 astronauts who were actively serving during this period, a total of 65 consented to and participated in this original data collection. The papers resulting from this study were the first and, to date, the only published formal investigation into personality and performance in this population. These original studies investigated the relationship between personality, as assessed by trait-assessment batteries, and performance as assessed by a series of peer and supervisory ratings of multiple parameters (perceptions of compatibility, perceptions of performance, and competence, etc.). Findings in these studies were modest, but suggested a possible link between interpersonal orientation and peer/supervisory rated performance (McFadden, Helmreich, Rose, & Fogg, 1994; Rose, Fogg, Helmreich, & McFadden, 1994; Rose, Helmreich, Fogg, & McFadden, 1993).

The second dataset analyzed in this present report was collected during the NASA astronaut recruitment campaigns that were held in the 6 years following the above study (i.e., from 1989 to 1995). Data were collected from the 259 astronaut applicants who participated in the NASA

final-stage astronaut selection process carried out during this period. Of the 259 astronaut applicants from whom data were collected at final selection, a total of 63 (12 female, 51 male) were eventually successful in their application to become astronauts. Formal analyses of these data have been presented previously (Musson, Sandal, & Helmreich, 2004).

It should be noted that subtle score differences in personality measures between those already selected and those undergoing selection have been described (Sandal, Musson, Helmreich, & Gravdal, 2004). The theorized difference between these two datasets is due to the tendency of job applicants to present themselves in an especially positive light due to their participation in the astronaut selection process at the time of testing. Even though the tests were presented to astronaut applicants as research measures, it is likely that there was either a halo of positive self presentation or a mistrust that the testing results would actually be used in selection, despite reassurances to the contrary.

Combining the two data sources described above puts the total number of astronaut subjects in this current analysis at N=65+63=128. It is recognized that the different conditions under which these two populations were assessed did in fact lead to small-but-systematic biases in the scores in personality traits. Records indicate that consent was obtained from subjects in both data collections for the use of these data for ongoing selection and performance studies. Guarantees of both anonymity of participation and arms-length separation of these data from NASA management were assured as a condition of participation, and these promises have been kept to date by the principal investigator of those studies (Helmreich) and his associates (i.e., the author of this report).

3. Personal Characteristics as Predictors of Performance

The overall aim of the analysis presented in this report is to examine the relationship between individual factors (i.e., predictors), identifiable at the time of selection, and career activity (i.e., performance) as an astronaut. Funding for the analyses presented in this report did not include the collection of new data on astronaut performance beyond those data that were already available in the public domain. Unlike the original studies, described above, that looked at peer/supervisory assessments or perceived competence, interpersonal skill, and social compatibility for a proposed long-duration flight, the present analysis relies on metrics derived

from flight assignment and career progression. As will be discussed later in this report, lack of a clear theoretical alignment between predictors and outcome is less likely to demonstrate significant results in the analysis, compared to studies where those two factors more theoretically align. For a detailed discussion of this concept, the reader is referred to Hogan and Holland, 2003.

The predictors available for analysis in this report fall under two broad categories: **Demographic** predictors and psychological **Trait** predictors.

Demographic predictors. Demographic variables are easily identifiable from public record and include: age, gender, military service versus non-military service, pilot versus mission specialist, academic background (engineer, medical doctor, scientist), and educational level. In general, these are not of particular interest in the present analysis except as potential explanations of variance that are not attributable to personality traits.

Trait predictors. Specific trait variables, assessed in the two astronaut population groups, are appended in some detail in **Appendix A.** The instruments used to collect these data represented those tools that had been used in aviation performance studies by the principal investigator of the original astronaut performance study conducted in 1989 (Helmreich), along with adaptations of additional scales that were emerging in the literature at the time of the original study. Details of these tests and scales are presented below.

Personality trait variables existent in the current datasets include the Instrumentality and Expressivity scales of the Personal Attributes Questionnaire and the Extended Personal Attributes Questionnaire (EPAQ) (Helmreich, Spence, & Wilhelm, 1981). Also included were scales from the Jenkins Activity Survey (Jenkins, Zyzanski, & Rosenman, 1971), the Personality Research Form (Jackson, 1997), the Work and Family Orientation Questionnaire (Helmreich, 1978), and modified versions of the NEO-Five Factor Inventory (NEO-FFI) questionnaire (Costa & McCrae, 1992), which was a relatively new measure at the time of assessment, and has since emerged to become the dominant trait battery currently in use in the field of organizational psychology. The five, 12-item scales of the NEO-FFI were reduced to five, 8-item scales to accommodate mandated restrictions in testing astronaut participants. Answer keys also were modified somewhat to accommodate the larger testing battery that was administered to the

astronauts. Formal comparisons were made between the full NEO-FFI and the modified versions used in these assessments (Musson & Helmreich, 2003) and, while some diminution in scale quality was evident, the scales still meet adequate levels of reliability for research purposes. Numbers of astronauts who have completed each of the scales of the abovementioned instruments are provided in **Appendix B** of this report.

There has been discussion over the years of *High Instrumental + High Expressivity*, *High Instrumental + Low Expressivity*, and *Low Instrumental* clusters in the astronaut (and other) populations, and of the predictive utility of these trait groupings in studies of personality and performance. These clusters also were categorized as the *Right Stuff*, *Wrong Stuff*, and *No Stuff* categorizations of aircrew (Chidester, Foushee, & Jensen, 1991), and represent an intuitively satisfying approach to describing personality types in this population. Reference to this clustering approach is included for completeness, and is not part of the current plan for data analysis since a clustering approach is unlikely to provide additional information over more commonly used linear predictive models of personality and performance. Cluster-based approaches have not gained mainstream acceptance in industrial-organizational and personality-performance research communities since the cluster-analysis model was first introduced in the 1980s.

A number of additional scalar personality variables are listed in **Appendix A**, such as those of the Personality Research Form and some scales from the Work and Family Orientation questionnaire. These variables also are not planned to be included in the analysis in this study, as a significant body of literature does not presently support the use of those scales in vocational performance research.

Personality trait variables that will be selected for analysis from the Helmreich inventory include:

- Instrumentality
- Expressivity
- Negative instrumentality
- Verbal aggressiveness
- Negative communion

- Mastery
- Work orientation
- Competitiveness
- Impatience/irritability
- Achievement strivings

Personality trait variables that will be selected for analysis from the NEO-FFI are the following:

- Neuroticism
- Extraversion
- Openness to new experience
- Agreeableness
- Conscientiousness

4. Outcome Variables – Quantifying Career Performance

Rating astronaut performance is extremely challenging. This is an unusually high-performance population, and the identification of criteria that may serve to distinguish levels of career performance is difficult. This challenge has been noted previously in publications and workshops (McFadden, Helmreich, Rose, & Fogg, 1994; Musson & Helmreich, 2005). NASA does not publicly discuss performance differences between individual astronauts, and there are no universally agreed-upon metrics of performance for this population. Furthermore, performance evaluations are sensitive topics under ideal circumstances and, in this highly competent, publicly scrutinized population, care must be taken to protect individuals from embarrassment, criticism, or negative career influences.

Peer and supervisory evaluations. Often, job performance measures in both research and organizational contexts include supervisory and peer ratings. This approach is justified by the assumption that peers and supervisors are in positions to make both specific and global assessments of individuals' performance and to make comparisons between individuals and other workers. In the context of this current report, this would include peer assessments of astronauts by other astronauts, supervisory assessments of astronauts by individuals in positions of authority within the NASA community, or ratings of astronauts by non-astronaut co-workers. Neither funding nor opportunity exists at the time of writing this report to pursue these additional performance measures, though this could be most valuable to pursue down the road. It should be noted that the original astronaut performance studies conducted by Rose and Helmreich failed to find statistically solid predictors of peer and supervisory ratings within this population (Rose, Fogg, Helmreich, & McFadden, 1994), though inferences were made to the relationship between traits related to interpersonal competence and perceived desirability for cohabitation, which makes intuitive sense. One of the main limitations of those analyses was the overall N being only 65, despite high levels of participation from the astronaut corps. The additional data that have since been collected effectively doubles that number.

In the absence of a funded effort to conduct peer or supervisory assessments, publicly available parameters of astronaut performance have been identified for this report as the most appropriate measure of job performance in this population. The public records include multiple parameters

that may be interpreted as measuring success/failure at both the mission and career level. Presumably, since superior performers are identified through peer networks, supervisory assessment and training performance evaluation (both formal and informal), early assignment to flights, assignment to high responsibility roles (e.g., mission commander or extravehicular activities [EVA]), more frequent flight assignments, and career longevity can all be theorized to serve as proxies for high internal assessments of competence and effectiveness within the astronaut corps. Possible outcome variables, based on observable career performance include:

Binary (Yes/No) outcome variables:

- Assignment of command positions on space flights
- Assignment to CapCom position
- Leadership positions within the Astronaut Office (i.e., chief or deputy chief of the Astronaut Office)

Scalar outcome variables:

- Time delay to first flight assignment
- Number of flight assignments
- Number of EVA assignments over an astronaut's career

Command positions and CapCom positions presumably relate to some measure of perceived competence. Election to leadership assignment would appear to be a meaningful measure of peer-assessed competence, trust, and/or likeability. Ten individuals in the dataset under review have occupied one or both of these leadership positions.

Time delay between recruitment and first flight is a relatively simple calculation and can be calculated for each astronaut in the NASA astronaut corps. Astronauts more rapidly assigned to a flight following training may indicate perceived higher levels of competence. This viewpoint is admittedly one of conjecture, and certainly many factors may affect such assignment. Still, it is a relatively easy variable to calculate and its face validity warrants exploration. Similarly, number of flights and number of EVAs for each astronaut can be calculated, and can be used for analysis. After some consideration, it was decided not to consider total flight time or number of hours of

EVA as performance metrics, as these data would appear to provide little additional information over and above numbers of flight assignments and number of EVAs.

5. Analyses of the Data

5.1 The personality data set

The above discussion of predictors and outcomes is presented to give context to the analysis that follows. As discussed, the N for these analysis is N=65+63=128. Of the existing data, exclusion of a modest number of individuals from the personality performance analysis is warranted.

A small number of those represented in this dataset began their careers well before most of the other respondents. Comparison of the career performance of these individuals with the rest of the corps is not a relevant comparison due to significant differences in career opportunities and highly differing opportunities for operational experience. These individuals will be excluded from the analysis.

Also, and most unfortunately, a number of individuals in this dataset are deceased. These astronauts never had the opportunity to live out their career to the extent that their colleagues were able to – as such, inclusion of these individuals in the analyses does not fit with predictors of long-term performance in the corps.

Specific numbers in each of these two exclusion categories are not provided to protect the anonymity of the respondents, consistent with the agreements made at the time of data collection. The dataset remaining after the exclusion of these individuals, which will be used for subsequent analysis, is as follows:

Demographics by Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FEMALE	22	18.5	18.5	18.5
	MALE	97	81.5	81.5	100.0
	Total	119	100.0	100.0	

With respect to the binary performance measures (assigned command position for flights, assigned to work as CapCom, appointed to chief or deputy chief of the Astronaut Office), the following tables provide breakdown of these variables within the astronaut career performance dataset:

Command Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Command	59	49.6	49.6	49.6
	Command	60	50.4	50.4	100.0
	Total	119	100.0	100.0	

CapCom

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CapCom	17	14.3	14.3	14.3
	No CapCom	102	85.7	85.7	100.0
	Total	119	100.0	100.0	

Leadership Position?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Chief or Deputy	10	8.4	8.4	8.4
	Neither	109	91.6	91.6	100.0
	Total	119	100.0	100.0	

Regarding the scalar outcome performance variables (number of missions, time to first flight, number of EVAs), the following values (mean, standard deviation) represent the performance characteristics in the constructed performance dataset used for these analyses. Specific ranges are not provided, as these could allow some identification of specific participants.

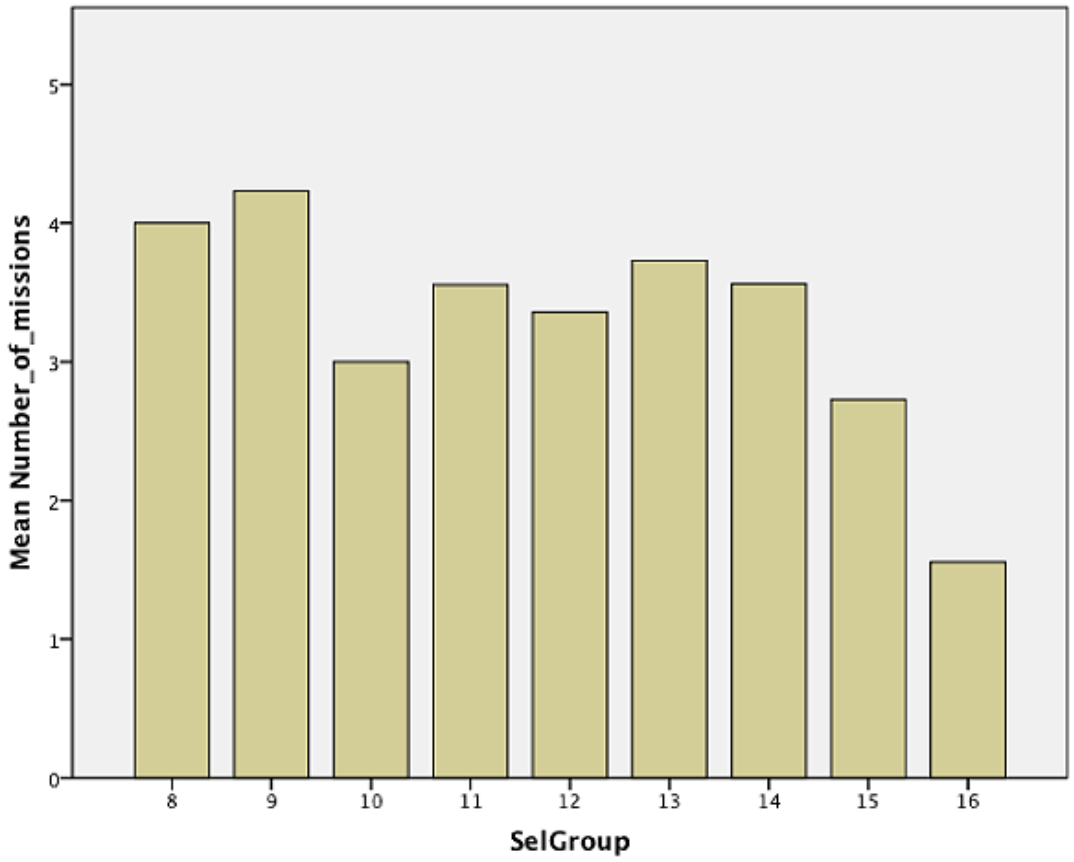
Number of Missions:	Mean = 3.40	Std dev = 1.284
Time to first flight:	Mean = 4.81 yrs,	Std dev = 2.168
Number of EVAs:	Mean = 1.35	Std dev = 2.200

5.2 Analytic strategy

The analytic strategy for this report is based on the fundamental predictive model that higher or lower scores on one or more trait scales result in higher or lower scores on a performance metric, or a greater likelihood of attaining a binary measure of career success. Pearson product or Spearman *rho* correlations, as appropriate, between predictor and outcome variables will be tested. For binary (yes/no) outcomes, an independent samples t-test comparing one group to another will be the preferred method. For all analyses, an alpha of 0.05 will be used as the statistical cut-off for determination of significance. It is recognized that failure to correct for the rather large number of comparisons conducted will result in an increased likelihood of finding correlations that are actually spurious, but the exploratory nature of these analyses and the unique and limited nature of these data suggest that such an approach is warranted. These deficiencies are acknowledged.

5.3 Demographic factors and astronaut career performance

Selection year and number of flight assignments. The relationship between selection year and number of flight assignments is shown graphically below. This is not a personality-performance predictor model, but is performed to test the naive hypothesis that the longer an astronaut serves, the more likely he or she is to have a greater number of flight assignments.



The above graph demonstrates the relationship between selection group (or class) and the mean number of flight assignments per class. The correlation between selection class and flight assignment, as suggested by the above graph, is significant, and the Spearman's *rho* correlation coefficient between group number and mean flights is 0.320, $p<0.001$. In other words, this means that astronauts selected in successive years were likely assigned to a fewer number of flights.

Gender and career performance: It is clear that the number of female astronauts is significantly less than the number of male astronauts in the current astronaut population compared to the general non-astronaut population. In our predictor/performance dataset of 129 individual astronauts, 23 are female and 106 are male (17.8% and 82.2%). While a full analysis of gender and its role in selection and astronaut careers is well beyond the scope of this project, the following was observed.

In the post-Apollo era of U.S. space flight (i.e., when females were eligible to be selected as astronauts), a total of 17 individuals were assigned chief or deputy chief positions in the

Astronaut Office. Of that number, 4 individuals were female and 13 were male (23.5% vs 76.5%), which closely approximates the distribution of gender within the population. Only one female has been chief during this period, whereas six males have held the post (14% vs 86%). The current dataset does not have adequate representation in leadership roles to justify controlling for gender as a potentially influencing variable of this parameter.

In the dataset being used for this analysis, the relationship between gender and flight assignment suggests no impact of gender on frequency of flight assignment. Female astronauts average 3.09 flights per career whereas males average 3.33 flights per career. This difference is not statistically significant.

The same is not true for EVAs, however. Only seven of 23 females in the dataset have performed EVAs (30%), whereas 53 of 106 males performed EVAs (50%). This result is statistically significant ($t = -3.320$, $p=0.001$, equal variances not assumed). Males who performed EVAs were also likely to perform additional EVAs, whereas this was not the case for females.

6. Trait Predictors and Performance

The decision was made to focus on two broad subsets, among the large number of personality variables in the existing database, as discussed earlier and based on support from the literature. The first variable set is the family of trait measures that is described in the astronaut performance literature as the Helmreich Personal Characteristics Inventory (or PCI). As a reminder, these trait measures include the following:

Instrumentality
Expressivity
Negative instrumentality
Verbal aggressiveness
Negative communion
Mastery
Work orientation
Competitiveness

Impatience/irritability
Achievement strivings

As mentioned elsewhere, the first five of these scales are drawn from the Personal Attributes Questionnaire (Helmreich, Spence, & Wilhelm, 1981), the next three from the Work and Family Orientation Questionnaire (Helmreich, 1978), and the last two from the Jenkins Activity Survey (Jenkins, Zyzanski, & Rosenman, 1971). These 11 scales were chosen because, among the non-Big Five (see below) scales that were included in this battery, they have the strongest justification for assuming a personality-performance relationship based on previous research (Helmreich, Spence, Beane, Lcker, & Matthews, 1980; Helmreich, Spence, & Pred, 1988).

Five additional personality scales are included in the analytic strategy for this project:

Neuroticism
Extraversion/introversion
Openness to new experience
Agreeableness
Conscientiousness

The scales used are variants of the scales designed to assess the well-known family of traits that are often referred to as the Big Five (McCrae, Costa, Pervin, & John, 1999). These specific scales are derived from the principal instrument used to assess the Big Five, the NEO-FFI developed by Costa and McCrae (Costa & McCrae, 1992). The Big Five have been the most popular personality trait scales in investigations of personality and performance over the last 15 years (Fruyt & Mervielde, 1999; Judge, Higgins, Thoresen, & Barrick, 1999; Mount & Barrick, 1991). It must be noted that these scales were modified at the time of testing in both scale length and answer key, so as to better integrate with the testing battery that was used for the original data collection. An analysis of these scales was conducted previously, and acceptable relationships to the original scales were demonstrated (Musson & Helmreich, 2003).

Significant differences were not found between male and female astronauts on any of the 10 scales, which is unlikely the case for the normal population. Scores are presented below with normative scores drawn from test populations for comparison.

	Astronauts		Female normative		Male normative	
	Mean	SD	Mean	SD	Mean	SD
Instrumentality	26.65	2.89	20.61	4.52	21.35	4.83
Expressivity	22.69	3.57	24.74	3.74	23.27	3.97
Negative instrumentality	10.01	4.39	11.14	4.67	13.35	4.49
Verbal aggressiveness	4.24	2.43	6.54	2.88	5.29	2.87
Negative communion	5.24	2.05	7.15	2.07	6.35	2.32
Mastery	22.99	3.59	18.89	4.77	19.12	4.38
Work orientation	22.53	1.60	20.62	3.06	19.07	3.73
Competitiveness	12.17	3.68	13.48	3.86	14.13	4.16
Impatience/irritability	9.84	2.84	10.40	3.88	10.70	3.51
Achievement strivings	18.28	3.14	14.38	3.79	13.71	4.49

Data from the existing astronaut personality database are presented above, along with normative data broken down by gender. Significant gender differences are not present in the astronaut data, suggesting a gender-independent astronaut profile. It can be seen in the table above that astronauts have higher-than-usual scores on Instrumentality and related scales, slightly lower scores than a normal population on Expressivity, as well as lower scores on Verbal Aggressiveness and Negative Communion.

	Astronauts		Female normative		Male normative	
	Mean	SD	Mean	SD	Mean	SD
Neuroticism	6.05	3.40	15.13	5.89	14.24	5.78
Extraversion	23.12	3.46	22.83	4.69	20.97	4.57
Openness	19.73	4.63	18.02	4.90	19.59	4.80
Agreeableness	24.71	3.21	22.35	4.07	20.22	4.16
Conscientiousness	26.66	3.20	21.69	5.04	19.28	5.65

Normative values are taken from Musson & Helmreich, 2003.

Big Five data from the astronauts are presented above, along with normative data from the general population. Again, systematic gender differences are not present in the astronaut data. It can be seen in the table above that the astronauts, as a population, have unusually low scores on Neuroticism, are mildly high on Extraversion, and are particularly high on Agreeableness and Conscientiousness. Particularly with Conscientiousness, a well-established predictor of

performance (Mount & Barrick, 1991), ceiling effects from uniformly high scores and the overall lack of individual variation within this population may diminish observable relationships between these measures and the various outcome parameters presented earlier.

Personality traits and command positions

The relationship between personality trait scores and assignment to in-flight command positions was explored. Of the 15 personality variables considered, only **Openness to New Experience** was significantly related, with command-assigned individuals scoring slightly lower than their non-command counterparts (18.60 vs 20.96), $t = 2.52$, $p=0.013$.

Personality traits and CapCom Assignment

The relationship between personality and assignment to CapCom positions was explored. Of the 15 personality variables considered, **none** showed a significant difference between those selected and those who were not.

Personality traits and administrative leadership (Chief/Deputy AO)

Independent samples t-tests were conducted comparing mean scale scores of those astronauts who have held leadership positions; i.e., those who have held the position of chief or deputy chief, Astronaut Office (N = 10), and those who have not (N = 114). Only one trait predictor variable showed a difference in mean scores with a significance of less than $p < 0.05$ – that being **Work Orientation**, ($t = -2.108$, $df = 122.000$, $p = 0.037$). Work Orientation has been defined as "reflecting a general desire to work hard." Interestingly, those astronauts who have held such leadership positions scored slightly lower than those who have not (mean score 21.7143 vs 22.5128) on this measure.

Personality trait scores and time to first flight

Time to first flight ranged from 2 to more than 9 years, with a mean of 5.04 years (SD = 2.636). Of the 15 personality scales, **Neuroticism** was positively correlated with time to first flight ($r = 0.2.15$, $p = 0.042$).

Personality trait scores and number of flight assignments

Number of flight assignments ranged from 0 to 7, with a mean of 3.29 flights per astronaut (SD = 1.324). No significant relationship was found between number of flight assignments and any of the trait predictors.

Personality measures and number of EVAs

Number of EVAs range from 0 to more than 7, with a mean of 1.29 per astronaut (SD= 2.141). As expected, number of EVAs correlated to some extent with number of flight assignments (r = 0.221, p = 0.012). However, EVAs also were correlated negatively with **Openness to new experience**, with r = -0.239, p = 0.020. No other correlations were identified.

7. Summary of Analysis

Data analyses showed weak to little correlation between demographic predictors and flight assignment, EVA assignment, and CapCom assignment with the exception of the relationship between gender and EVA assignment. Female astronauts were less likely than their male counterparts to be assigned EVAs, at least among our participants. No conclusions can be drawn in this report regarding the larger astronaut population where this difference may or may not persist, as those data were not analyzed. Selection year did indeed predict likelihood of flight assignment, though it has not been determined whether this is due solely to career longevity, or whether this difference is likely to remain at the end of the careers of those who were more recently recruited.

The tendency for those in **leadership positions** to score slightly less on **Work Orientation** compared to non-leadership colleagues is difficult to explain, though it may fit with lay theories held by workers regarding management in general.

Since opportunities for flight assignment vary significantly from year to year, it is difficult to compare astronauts recruited in one year to those recruited in another year (see the following section). Regardless, some modest correlations were identified. With respect to **time to first flight**, higher scores on **Neuroticism** were related to delayed first flight. This is consistent with a

theory that low levels of Neuroticism may be associated with perceptions of appropriateness for flight assignment. This also fits with traditional perceptions of test pilots and astronauts being calm-mannered individuals adept at handling the emotionally provocative environment of high-risk flight. Higher levels of Neuroticism may manifest as increased irritability, increased emotional liability, or ease of excitability. These manifestations could, in turn, lead to perceptions that some individuals are more prepared or more desirable for flight assignment.

The correlation between low scores on **Openness to New Experience** and **career EVAs** is more difficult to explain, and though possibly spurious, may warrant further study. Openness to New Experience is probably the least well-understood trait within the Big 5 family. Costa and McRae describe Openness to New Experience as relating to imagination, aesthetic sensitivity, attentiveness to inner feelings. Research also has suggested that this trait correlates with anti-authoritarianism (Butler, 2000). Individuals scoring higher on this trait may be perceived as less ideal for the specific nature of EVAs.

8. Suggestions for Next Steps

A valuable next step in this ongoing analysis would involve funding a more appropriate model of outcome measures. Personality, in this population is unlikely to have significant impact on the measures considered in this study (and the analyses herein confirm this statement). All selected astronauts had impressive records of achievement before selection, which is a fact consistent with their uniformly high scores on achievement and motivational traits presented in this report. In such a population, many factors over and above personality are likely to account for variation in the blunt, insensitive metrics that were used in these analyses – factors such as previous experience and technologically specific knowledge certainly contribute to flight selection, EVA selection, and CapCom assignment. Where personality is more likely to have an impact is in less technical metrics. Measures assessing appropriateness for long-duration cohabitation, crew selection for multicultural missions, and other socially oriented factors are likely to be based largely on personal characteristics. Peer assessments of desirability on such scales should more closely align with personality traits, and such an analysis should focus on whether standardized personality measures are able to identify those individuals destined to be peer-identified as more desirable for such duty roles. Traits likely to predict such assessments would include

Agreeableness, Expressivity, and other traits related to social interaction. Among those predictors, the astronaut population shows more similarity to the general population, and variability is greater than on achievement-related traits in this population. Such a study would require revisiting methodology, and would most certainly require new ethics reviews, informed consent, and high degrees of collaboration from the active and retired astronaut population.

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APPENDIX A – Personal Characteristic Scales

Astronaut version of the Personal Characteristics Inventory Subscales and their test origins.

Personal Attributes Questionnaire (PAQ)/ Extended Personal Attributes Questionnaire (EPAQ) – Helmreich and Spence

Helmreich, R. L., Spence, J. T., & Wilhelm, J. A. (1981). A psychometric analysis of the Personal Attributes Questionnaire. *Sex Roles, 7,* 1097-1108.

1. Positive expressivity
2. Instrumentality
3. Bipolar instrumentality
4. Negative instrumentality
5. Negative expressivity – verbal aggression
6. Negative expressivity – negative communion

Work and Family Orientation Questionnaire (WOFO) – Helmreich and Spence

Helmreich, R. L. (1978). The Work and Family Orientation Questionnaire: An objective instrument to assess components of achievement motivation and attitudes towards family and career. *JSAS Catalog of Selected Documents in Psychology, 8*(35), MS 1677.

1. Mastery
2. Work orientation
3. Competitiveness
4. Work involvement
5. Joy in work
6. Job involvement
7. Perfectionism
8. Driven

Jenkins Activity Survey (JAS) – Jenkins

Jenkins, C. D., Zyzanski, S. J., & Rosenman, R. H. (1971). Progress toward validation of a computer-scored test for the Type A coronary prone behaviour pattern. *Psychological Medicine, 33,* 193-202.

1. Impatience/irritability
2. Achievement striving

Personality Research Form (PRF) – Jackson

Jackson, D. N. (1997). Jackson Personality Research Form. Port Huron, MI: Sigma Assessment Systems.

1. Affiliation
2. Dominance
3. Endurance
4. Impulsivity

5. Succorance
6. Alienation
7. Vigor

Neo Five Factor Inventory (NEO-FFI) – Costa and McCrae – Modified

Costa, P. T., & McCrae, R. R. (1992). *NEO PI-R Professional Manual*. Odessa FL: Psychological Assessment Resources, Inc.

1. Neuroticism
2. Extraversion
3. Openness
4. Agreeableness
5. Conscientiousness

Additional scales from the Spence Workaholic research measures

1. Joy In Work (JOYINWORK)
2. Job Involvement (JOBINVOL)
3. Perfectionism (PERFISM)
4. Time Commitment (TIMECOMM)
5. Work Driven (DRIVE)

APPENDIX B – Number of Respondents

Number of astronauts who completed each of the astro-PCI personality trait scales

PAQ/EPAQ	N
Instrumentality	128
Expressivity	128
Bipolar Instrumentality	127
Negative Instrumentality	129
Verbal Aggressiveness	129
Negative Communion	128

WOFO	N
Mastery	129
Work Orientation	128
Competitiveness	129

JAS	N
Impatience/Irritability	128
Achievement Strivings	128

NEO-FFI (Modified)	N
Pci-Neuro	104
Pci-Extra	104
Pci-Open	104
Pci-Agree	104
Pci-Consc	104

PRF	N
Affiliation	41
Dominance	63
Endurance	63
Impulsiveness	63
Succorance	63
Social Alienation	63
Physical Vigor	41

Spence Work Scales	N
Work Driven	60
Joy In Work	60
Job Involvement	60
Perfectionism	38
Time Commitment	60

APPENDIX C – Right Stuff Cluster Definitions

Personal Characteristics Inventory clusters defined Right Stuff, Wrong Stuff, No Stuff.

Cluster 1 (positive instrumental/expressive)

(Right Stuff)

Above average in:

Instrumentality (EPAQ)
Expressivity (EPAQ)
Mastery (WOFO)
Work (WOFO)

Below average in:

Negative Instrumentality (EPAQ)
Verbal aggressiveness (EPAQ)

Cluster 2 (negative instrumental)

(Wrong Stuff)

Above average in:

Instrumentality (EPAQ)
Negative Instrumentality (EPAQ)
Verbal Aggressiveness (EPAQ)
Work (WOFO)
Mastery (WOFO)
Competitiveness (WOFO)

Below average in:

Expressivity (EPAQ)

Cluster 3 Low motivation (No Stuff)

Low scores in the following scales:

Instrumentality (EPAQ)
Expressivity (EPAQ)
Mastery (WOFO)
Work (WOFO)
Competitiveness (WOFO)

APPENDIX D – Chiefs of the Astronaut Office

Chief and Deputy Chief of the NASA Astronaut Office (1962-2010)

1. Deke Slayton (September 1, 1962 - November 1963)

2. Alan Shepard (November 1963 - July 1969)

3. Tom Stafford (July 1969 - June 1971) (Stafford held the position while Shepard prepared for and flew Apollo 14)

4. Alan Shepard (June 1971 - August 1, 1974)

5. John Young (January 14, 1974 - April 15, 1987), Deputy was Paul J. Weitz. Acting Chief during STS-1 training was Alan Bean.[1]

6. Dan Brandenstein (April 27, 1987 - October 1992), Deputy was Steven Hawley.

7. Robert Gibson (December 8, 1992 - September 6, 1994), Deputy was Linda Godwin.

8. Robert Cabana (September 6, 1994 - October 1997), Deputy was Linda Godwin.

9. Kenneth Cockrell (October 1997 - October 1998)

10. Charles Precourt (October 1998 - November 2002), Deputy was Kent Rominger.

11. Kent Rominger (November 2002 - September 2006), Deputies were Andy Thomas and Peggy Whitson.

12. Steven W. Lindsey (September 2006 - October 2009), Deputies were Janet Kavandi and Sunita Williams (February 2008 to October 2009).

13. Peggy Whitson (October 2009–present) Deputy is Chris Ferguson. [3]

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This report presents an analysis of an existing astronaut psychological trait dataset and the relationship between those data and publicly available metrics of astronaut career performance. The overall aim of this analysis is to examine the relationship between individual factors (i.e., predictors), identifiable at the time of selection, and career activity (i.e., performance) as an astronaut. Sections include: outcome variables (quantifying career performance); analysis of the data (the personality data set, analytic strategy, and demographic factors and astronaut career performance); trait predictors and performance; a summary of the analysis; and suggestions for next steps.This project is funded by a contractual agreement between the author and the Behavioral Health and Performance Research Element at EASI/Wyle and NASA. This work was undertaken for the purpose of informing future selection strategies for astronaut applicants, and to create a better understanding of the relationship between individual psychological characteristics and the job of being an astronaut.

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