



# LUND UNIVERSITY

## Pilots and ground officers investigated by process tests of creativity, extraversion, and stress control

Carlsson, Ingegerd; Amnér, Gunilla; Smith, Gudmund

*Published in:*

Process and Personality. Actualization of the personal world with process-oriented methods

2008

[Link to publication](#)

*Citation for published version (APA):*

Carlsson, I., Amnér, G., & Smith, G. (2008). Pilots and ground officers investigated by process tests of creativity, extraversion, and stress control. In G. Smith, & I. Carlsson (Eds.), *Process and Personality. Actualization of the personal world with process-oriented methods* (pp. 201-220). Ontos Verlag.

*Total number of authors:*

3

### General rights

Unless other specific re-use rights are stated the following general rights apply:

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: <https://creativecommons.org/licenses/>

### Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117  
221 00 Lund  
+46 46-222 00 00



# LUND UNIVERSITY

Department of Psychology

---

## LUP

Lund University Publications  
Institutional Repository of Lund University  
Found at: <http://www.lu.se>

This is an author produced version  
of a chapter published in

Smith, G.J.W. & Carlsson, I.M. (Eds.) (2008) Process  
and Personality. Actualization of the personal world with  
process-oriented methods.

This chapter has been peer-reviewed.

Citation for the published chapter:  
Carlsson, I., Amnér, G., & Smith, G. W. (2008). Pilots and  
ground officers investigated by process tests of creativity,  
extraversion, and stress controll.

Frankfurt: Ontos Verlag, pp 201–220.  
Published with permission from [www.ontosverlag.com](http://www.ontosverlag.com)

ISBN 13: 978-3-938793-89-3

Access to the published version may  
require subscription.

# **Process and Personality**

## **Actualization of the personal world with process-oriented methods**

Gudmund J. W. Smith and Ingegerd M. Carlsson  
(Editors)

**Published in remembrance of Ulf Kragh**

Copy – editing: Axel Smith

Department of Psychology, Lund University, P.O. 213, SE-221 00, Lund,  
Sweden

Tel. (46) 46 2220000, fax (46) 46 2224209

Gudmund.Smith@psychology.lu.se

Ingegerd.Carlsson@psychology.lu.se

# 12. PILOTS AND GROUND OFFICERS INVESTIGATED BY PROCESS TESTS OF CREATIVITY, EXTRAVERSION, AND STRESS CONTROL

**Ingegerd Carlsson, Gunilla Amnér and Gudmund Smith**

*In an exploratory investigation of personality patterns, Swedish air force pilots ( $n = 22$ ) and ground officers ( $n = 14$ ) were tested with the Creative Functioning Test, the Serial Color Word test, and the Spiral After-Effect Technique. The participants also answered open questions about their work and about creativity related items. Achievement ratings were made by their superior officers.*

*An initial discriminant analysis separated the groups to 83.3 %. Next, cluster analyses were conducted on the test results, resulting in three pilot clusters and three ground officer clusters. The pilot clusters were interpreted as forming meaningful groups, in agreement with previous research. Thereafter the clusters were compared with the results on the open questions. The significant answering categories gave face validity support to the clusters.*

*It was concluded that it is important to investigate personality patterns, as measured by process tests, and, in future research, to make comparisons with biological markers as well as questionnaires.*

Are pilots creative? This question was put to the present investigators by the head of a Swedish wing and was the origin of this investigation. However, when venturing upon our task to study air force pilots, we felt it important to include other personality dimensions as well.

Earlier research has brought out the importance of personality factors for pilots (Cattell, Eber, & Tatsouka, 1970), who have been characterized by emotional stability and extraversion (Bartram, 1995; Bartram & Dale, 1982; Jessup & Jessup, 1971; Okaue, Nakamura, & Nira, 1977; Reinhardt, 1970). The creativity dimension was found to have been little studied in pilots (but cf. Bachelor & Michael, 1991). Most previous research has used

self-report scales, however, and it has been argued that such scales are less apt to discriminate in small samples (John, 1989). Since the present study comprised a limited number of participants, we decided to try behavioral tests as alternatives to self-report scales. Thus, the stability, or cognitive control dimension, was measured “on-line” in a pressing situation, while creativity, as well as extraversion, were studied with perceptual techniques.

Stress can be defined as a psychophysiological reaction to adaptive demands in new or challenging circumstances (Levi, 1981). Coping with stress implies constantly changing cognitive and behavioral efforts (Lazarus & Folkman, 1984), and the interaction between demands and control is of importance (Karasek & Theorell, 1990). In the present study we investigated individual differences in keeping a stable control, when adapting over time to a (modified) Stroop test, namely The Serial Color Word Test (Smith, Nyman, Hentschel, & Rubino, 2001). The pilots in particular were assumed to manage this test in an even and stable manner.

Another basic requirement for pilots is the ability to appreciate the outside world relatively free of valuation and close to “facts”, that is extraversion (Eysenck, 1967). This dimension was investigated with an implicit perceptual technique, namely the The Spiral After Effect Technique (Andersson, 1995). A low proportion of introverted subjectivity was thus expected in the present cohort.

The creative personality has been characterised by originality, independence and introversion, as well as androgyny, and an interest in complexity and elegant solutions (Barron, 1988; Carlsson, 1992; Crutchfield, 1964; Jönsson & Carlsson, 2000). In a strict organisation with minutely defined functions, any creative activity must be kept within firm frames (Amabile, 1983; Ekvall, 1991). We therefore expected to find few officers with high creativity. But since a flexible hold was considered important, a relatively large proportion of creativity in the middle range was presumed. Thus, the final test battery encompassed, besides the aforementioned tests of extraversion and stress control, also the Creative Functioning Test (Smith & Carlsson, 2000). These personality variables were furthermore compared with answers to open questions and with achievement ratings made by each participant's superior officer. For sake of comparison, a group of ground officers was included in the investigation.

According to Magnusson and Törestad (1993), pattern description is a first step towards an understanding of the interaction of different subsystems in the personality. Hence, this investigation could be described as an exploratory study with the aim to find out if different combinations of personality factors would form meaningful subgroups among the participants.

## **MATERIALS AND METHODS**

### *Participants*

All available pilots, and a selected group of other young officers, employed at a Swedish wing, were asked to participate by the head of the wing. No one refrained from participation. The pilot group consisted of 22 men (age 24-42 years,  $M = 29.9$ ). There was one colonel, two majors, four captains, three first-, and twelve second lieutenants among the pilots.

The ground officer group consisted of five women and nine men (age 24-32 years,  $M = 28.9$ ). There were four captains, five first- and five second lieutenants. None of the ground officers had a pilot education. They worked as fighter controllers, engineers, and instructors. The participants comprised about one tenth of the employees at the wing.

### *Procedure*

An introductory letter together with a questionnaire with open questions was sent to the participants in advance. In it the participant was guaranteed of confidentiality. The questionnaire was returned to the experimenters before the testing. The testing was done at the wing. One experimenter gave the tests of creativity and extraversion, and the other one administered the stress test, checked for missing answers in the questionnaire, and did the debriefing.

### *Achievement Rating Scale*

The achievement rating scale was part of the regular assessments at the wing. It consisted of eight variables (expertise, work capacity, intellectual flexibility, discrimination of judgement, psychic stability, co-operation, leadership and physical fitness), rated on a five-grade scale. Each participant was rated against next higher grade by his or her superior officer.

### *Questions about Work and Creativity*

The questionnaire contained 22 open questions. Half of them were related to the work, for example, what was important at the work; which were positive and which were negative aspects; stressful moments; positive press; and if the person was contented with his/her present work, or wanted to do something else. The other half was related to creativity (Smith & Carlsson, 1990), for example, which were the person's interests; which were his or her dreams, if opportunity was given; did the person consider him-/herself logical or more apt to get ideas; did he or she prefer to be alone or together with other people; and from what age he or she had childhood memories. Finally, the participant was asked to describe what he or she considered to be most important in life.

### *Creative Functioning Test (CFT)*

The stimulus picture in the CFT is a still life drawn in black and white depicting a bottle and a bowl. The picture, drawn by an artist, is built up by shadings and diffuse contours making it fairly easy to see other things in it (e.g., a face, a body, or a landscape). The participant is instructed that pictures are to be shown very briefly, but not that they are one and the same picture. He or she is asked to describe after each exposure what was shown on the screen, even if they are not quite certain. The test consists of two connected exposure series, one with increasing exposure times and the next with decreasing times. In the increasing series the exposures (shown with a tachistoscope) start with .02 sec. and are slowly prolonged until the participant has described the stimulus as consisting of two objects, a bottle and a bowl. At this point the time increase is halted and reversed, to continue into the decreasing series. During this part of the test, the exposure times are successively shortened, and end when nothing at all can be discerned. Further technical and experimental specifications can be found in the manual (Smith & Carlsson, 2000).

*Creativity dimensions in the CFT.* A first crucial dimension of relevance for creativity is the ability to form mental representations of the indistinct contours and shapes glimpsing on the screen. This ability is tried in the in-

creasing series, in which the perceived meanings can vary considerably between individuals. The number of different interpretations in the increasing series correlated moderately with independent criteria of creativity (Smith & Carlsson, 1990). However, in this part it is difficult to distinguish between associating fluency on the one hand and the ability to shift from rational thought to more primary process oriented cognition on the other. This distinction was put to the test in the decreasing portion of the CFT: Thus, when the participant has got a hold on the visual contents in the picture, this "objective" perception supposedly exerts a considerable influence on the viewer. Relying on rational analysis, individuals would treat their own subjective picture interpretations as incorrect and in the decreasing series would comply with what seems as "the right answer". From a more cognitivistic perspective, a formulation such as "creativity...produced by an absence of cognitive inhibition" (Eysenck, 1995, p. 253) is feasible. Thus when correct recognition has been attained, a low-creative person would inhibit, or not consciously attend to, any subjective interpretation from the increasing series during the decreasing part. On the other hand, highly creative individuals would be inclined to shift from rational (secondary) thought processes and assign priority to their subjective (imaginary) representational world. In other words, they would prefer to perceive complexity rather than the simplicity of the logical solution.

*Scoring.* In the increasing series the number of different interpretations (for example a person or a landscape) adds up to a measure of *creative fluency*. Next, in the decreasing series, the ability to shift from rational thought to more holistic cognition, or *creative flexibility*, is put to a test.

*Final classification.* In the manual the scale for the decreasing series consists of six steps which were in this study compressed into three levels: *High* (steps 4 – 6): The whole or a substantial part of the picture is eventually interpreted in a completely different way. *Medium* (steps 2 – 3): Only vague changes or plastic transformations of the picture. *Low*: No change, or at the most that the picture is perceived to get foggy or darker.

*Validity.* Correlations have ranged from .46 to .83 with richness of ideas, expressiveness and originality, creative interests, and predictions of creative achievement. This has been judged by external raters in studies of researchers, professional artists, children and youngsters (Smith & Carlsson,



1990), and students of architecture (Schoon, 1992). Creative flexibility has been shown to correlate with symmetrical frontal brain activity (Carlsson, Wendt, & Risberg, 2000). In the present study the authors blind-scored the protocols independently of one another. In a few cases of dissension, another experienced rater made the final verdict.

### *Serial Color-Word Test*

The Serial Color-Word Test (S-CWT) is a modification and extension of the Stroop test (Thurstone, 1944). In the S-CWT the process of adaptation is closely registered when a person tries to cope with several repetitions of the pressing task to name the printed color of the color-word, not the printed word. (For a thorough description of all statistical procedures, consult the manual, Smith, Nyman, Hentschel, & Rubino, 2001).

The test material consists of a pre-test with groups of colored Xs, and a main test, preceded by one proper test line used as an introduction. The main test is a sheet with 100 color-words on ten lines. Reading time is registered at every second line. Five repeated readings of the sheet are made. Thus, altogether 5 x 5 time values are recorded.

*Scoring, basic classification.* The scoring is founded on calculations of two basic measures. One is the *linear* time change, i.e. decrease (improvement) or increase (impairment) in reading time. The other is degree of *instability* or variability over time, the variation ascribable to linear decrease or increase being excluded. Four strategies (S, C, D, CD) have been identified outgoing from the above measures. The stabilised (S) style represents an even speed with slight improvement between the five part times on a sheet. The cumulative (C) style implies that the reading times increase on the sheet. It has been related to anxiety and compulsiveness. The dissociatives (D) are unstable, i.e. vary between fast and long part times. They have proven sensitive to increasing stress, accident-prone and more frequent in psychosomatics or in psychosis. The cumulative-dissociative (CD) type has both increasing and unstable times. It is more common in psychiatric samples. It should be noted that people classified as CD from a non clinical sample usually have less extreme values than clinical samples, since reading times are shorter.

*Final classification.* Three final classifications are made. First, *primary type* (*S*, *C*, *D*, *CD*, or *unclassified*), where each of the five sheets is assigned a style, and the classification is in most frequent style. Next, the *secondary types* (*S*, *C*, *D*, *CD*) for linear regression (*R*) and for variability (*V*) are classified on the basis of a calculation where each sheet is considered as a subtest. Third, *initial types* (*high* or *low*) are analyzed. The *high* type implies a rapid change from initial long times to much shorter times, and has been connected with compulsiveness.

*Validity.* The diagnostic usefulness has been demonstrated in close to 60 studies (for further data and references, consult the manual, Smith et al., 2001). Reliability studies with a parallel test yielded correlations from .56 to .89. The present data were run on a computerised program with norms for age and sex.

### *Spiral Aftereffect Technique*

The Spiral Aftereffect Technique (SAT) is claimed to reflect the balance between subjective and objective factors in the experience of a visual aftereffect (Andersson, 1972, 1995). Even though the visual aftereffect is of neurophysiological origin, this balance influences it. Brief aftereffect durations imply that the viewer cuts off any subjective contribution to his experience of illusory movement, that is *extraversion*. Very long durations on the contrary imply that the subjective world is emphasised at the cost of objectivity, that is *introversion*. Aftereffects of a medium length represent a balanced approach.

The test material is installed in a portable apparatus. First a rotating spiral is shown during 45 seconds and immediately thereafter replaced by a non-moving circle. The participant is instructed to fixate the middle point of the rotating spiral. When the circle appears, the person reports when he considers the aftereffect to have stopped. Immediately after that a new trial follows, until ten trials have been made. A chronometer connected to the apparatus registrates the time.

*Scoring.* Two basic measures are made. First, the stabilized level is calculated as the mean value of the two final trials. Secondly, change of the duration over the ten trials is measured, i.e., increasing (+), decreasing (-), or unchanging (0) times.

*Final classifications.* Very low (*LL*), or low aftereffects (*L-*, *L+*) imply a reliance on extraceptive signals; medium lengths (*M-*, *M0*, *M+*) show a balanced hold; and high aftereffects (*H-*, *H+*) indicate that subjective signals dominate. (For details, consult Andersson, 1995).

*Validity.* Neuroticism on the Maudsley Personality Inventory (MPI (later EPI), Eysenck, 1959) has been found to coincide with long aftereffects (Andersson, 1969), which also proved typical of people with neurotic conflicts and depressive inhibition (Amnér, 1997; Andersson & Bengtsson, 1985). A medium level has correlated with warmth in contacts. Extraverts on the MPI more often had low aftereffects with minus trend (Andersson, 1969). Decreasing aftereffects (minus trend), or a low level, have coincided with a certain cool and reserved attitude (Andersson, Almgren, Englesson, Smith, Smith, & Uddenberg, 1984). University teachers with brief aftereffects more often described their organization as open (Ryhammar & Smith, 1999).

## RESULTS

There were no significant correlations between the three behavioural tests.

### *Achievement Rating Scale*

Mean score on the achievement scale for the pilots was 31.8, and for the ground officers 28.9. This difference was significant ( $t(34) = 2.91$ ;  $p < .01$ , two-tailed). None of the youngest pilots ( $n = 6$ ; age 24 – 26 years) got scores above the mean ( $p = .02$ , Fisher's exact test).

### *Questions about Work and Creativity*

The answers to the open questions were coded in two or three categories for each question. The protocols were then blind-rated by the experimenters. Certain questions were re-coded and rated anew, until consensus was reached. To minimise bias, the raters did not know the results of the tests administered by the other experimenter. Moreover, the scoring was done in advance of the further analyses. The pilots and the ground officers were found to differ on two questions. The pilots emphasised flying as positive

press ( $\chi^2_{corr.} = 7.93, p < .01$ ) and saw insecure employment as a negative aspect of their work ( $\chi^2_{corr.} = 4.24, p < .05$ ).

### *Questions about Creativity vs the CFT*

The creativity questions have as an index earlier proven relevant for creativity as measured by the CFT (Smith & Carlsson, 1990a). In the present group this was not the case. Instead, certain questions sorted out answers given by the highly plus medium creative people from the low creative ones. Thus, for the creative people *freedom, challenges and comradeship* were important work aspects ( $\chi^2_{corr.} = 5.12, p = .02$ ). Positive press implied *responsibility and/or self-development* ( $\chi^2_{corr.} = 4.52, p < .05$ ). *To be alone* was regarded as more positive than being in company with others ( $p = .01$ , Fisher's exact test). Finally, *either one's own self or the self of another person* was regarded as most important in life, rather than viewing oneself in relationship with other people ( $\chi^2_{corr.} = 6.02, p = .01$ ).

### *Discriminant Analysis*

A stepwise canonical discriminant analysis for pilots versus ground officers was performed (Klecka, 1980), comprising 42 variables (the test variables, sex, age, and superiors' ratings). The prediction of group was successful for 83.3 %. Significantly contributing variables were *achievement rating* ( $r = -.61, p < .001$ ), *high after-effects (H)* ( $r = .44, p < .01$ ), and *instability during stress (D / CD)* ( $r = .34, p < .05$ ). Thus, the pilots got higher ratings, and had less introversion and less unstable stress control than the ground officers. Another differentiating variable, which, for statistical reasons, did not play part in the analysis, was increasing reading times (*primary C*) on the stress test, found in eight pilots but none of the ground officers ( $p < .05$ , Fisher's exact test).

### *Cluster Analyses*

Since the pilots and ground officers were distinctive groups, it was deemed appropriate to look for subgroups within each. Using the above 42 variables, hierarchical cluster analyses (Ward) were performed (Everitt, 1980). Based on squared Euclidean distances, the Ward analysis provides valid estimates of the connections in four-field tables. Solutions with either two

or three clusters were tried, and solutions with three clusters were settled on, since they yielded more significant connections with the questionnaire.

Thus, after the clustering, in a second step, the questionnaire was tested for significance against the clusters. The differentiating answers are listed in the bottom part of tables 12.1 (the pilots) and 12.2 (the ground officers). Finally, the complete questionnaires were checked again, and two more differences between the clusters were then noticed that had not previously been categorized. These additional categories are added below in the text for those clusters that were concerned.

**Table 12.1.** Overview of the Pilot Clusters

		<b>P1</b>	<b>P2</b>	<b>P3</b>	
		<i>n</i> = 6	<i>n</i> = 9	<i>n</i> = 7	<i>P</i> -values
	<b>Categories</b>				
S-CWT	Primary C	0	3	5	< .05
S-CWT	Secondary Cv	1	3	7	< .01
S-CWT	Primary D or CD	2	0	0	.05
S-CWT	Secondary Dv or CDv	3	5	0	.05
S-CWT	Initial types low	0	4	0	< .05
SAT	L-	6	0	1	.001
SAT	L total (LL not included)	6	0	2	< .001
SAT	M-	0	5	0	< .01
SAT	M total.	0	8	0	.001
SAT	Minus-strategy	6	5	1	< .01
<b><i>Answering categories in the questionnaire</i></b>					
3a. Positive aspects of work	Freedom / challenge / comrade-ship	6	7	2	.01
3b. "	Freedom, etc., and leadership	0	1	5	< .01
5. Stressful aspects	Feel insufficient, get assessed	4	0	3	< .02
6. Positive press	Flying / challenges / strain	6	7	2	< .02

**Table 12.2.** Overview of the Ground Officer Clusters

		<b>G1</b>	<b>G2</b>	<b>G3</b>	
<b>Categories</b>		<i>n</i> = 4	<i>n</i> = 6	<i>n</i> = 4	<i>P</i> -values
S-CWT	Primary S	4	4	0	.01
S-CWT	Secondary Sr	3	5	0	.02
S-CWT	Secondary Sv	3	0	0	< .01
S-CWT	Secondary Cv	0	4	0	.02
S-CWT	Secondary Cr	0	0	2	.05
S-CWT	Primary D	0	0	3	< .01
S-CWT	Primary D or CD	0	0	4	< .001
S-CWT	Initial types low	0	1	3	< .05
CFT	Fluency > 2.5 themes	4	1	2	< .05
CFT	Flexibility, high or medium	1	6	1	.02
SAT	All L strategies (LL not included)	3	0	1	< .05
<b><i>Answering categories in the questionnaire</i></b>					
10a. Future work	Satisfied with present work	4	1	1	.02
10b. "	More responsibility – make a career	0	4	3	.05
13. Dreams	Family, home, and the like	4	1	3	.02
14. Logical or ideas	Get ideas	0	1	3	< .05

*Pilot cluster 1* ( $n = 6$ , age 25-28,  $M = 27$  years). All were extraverted. On the questionnaire all regarded flying, freedom, and the challenge of an advanced technology as positive aspects, but most described that they sometimes felt insufficient. Further, due to the cut-off point, age did not influence the clustering, but afterwards the mean age was found to be lower than for the other pilots ( $p = .01$ ). As one pilot wrote, "flying is still no everyday business for me".

*Pilot cluster 2* ( $n = 9$ , age 24-42,  $M = 31$  years). This group collected all those with a balance between extra- and introversion as well as low initial types on the stress test. On the questionnaire most stated the importance and positive press of flying, freedom, and challenges. None mentioned feeling inadequate.

*Pilot cluster 3* ( $n = 7$ , age 26-42,  $M = 32$  years). All had increasing reading times on the stress test. On the extraversion test none was balanced. They stated in the questionnaire that leadership was important besides the challenges, freedom and comradeship. Further, afterwards was found that all but one complained about a stiff hierarchy or the many rules, in contrast to four of the other pilots ( $p < .02$ , Fisher's exact test).

*Ground officer cluster 1* (3 men and 1 woman, age 25-32,  $M = 30$  years). This group showed high stability on the stress test, and creative fluency. Most were extraverted. On the questionnaire everyone was content with his or her present work position. Their dreams centred on the family. None felt apt at getting new ideas. In addition, when we afterwards read through all protocols, they were all found to mention having an interest in technical things, in contrast to only one of the other ground officers, ( $p < .01$ , Fisher's exact test).

*Ground officer cluster 2* (3 women, 3 men, age 24-30,  $M = 28$  years). Everyone had medium creative flexibility. None had low after-effects. Most were stable on the stress test. Several expressed a need for further development, while only one was satisfied with the present position or wanted more leisure.

*Ground officer cluster 3* (3 men, 1 woman, age 25-32,  $M = 29$  years). These people were unstable during strain. On the questionnaire most felt prone to get new ideas.

## DISCUSSION

As predicted, the pilot group had better stress control and were less introverted than the ground officers. They also got higher achievement ratings. It is probable that the thorough selection of pilots contributed to a well-functioning group with good control. But it seems that experience also contributed, since none of the youngest pilots got high ratings by their superiors.

### *Stress Control*

It appears favourable for the wing that few participants showed instability when stressed. It is probable, that the distribution for the pilots on the Se-

rial Color-Word Test is not the same as in the population at large. Only two, young, pilots had an unstable stress control. Good control, or executive functioning, is crucial for not becoming disorganized when dealing with rapid changes (Kyriazis, 1991).

Regarding the ground officers, the stability in the first group was paradoxical, since their work appeared less pressing. Of interest is that for this group the stress test resulted in a pervading evenness on all classifications. In these technically minded people a more active inhibiting mechanism may have contributed to somewhat over controlled reactions (Gray, 1970; Pickering & Gray, 1999). As described by Clark and Watson (1999), constrained and conscientious people “plan carefully, avoid risk and danger, and are controlled more strongly by the long-term implications of their behaviour” (p. 403).

### *Extraversion*

Only two pilots were introverted on the SAT, which was in line with earlier research. The other pilots showed extraversion, or a balanced hold. The youngest, “hot pilots” (Tempereau, 1956) had an extraverted reaction, which could be a strategy to compensate for their relative lack of experience. This objective hold may have had the positive effect to make them more aware of limitations in their own performance. Not realising own inadequacies has been found characteristic of pilots involved in serious accidents (Alkov, Gaynor, & Borowsky, 1985). Extraversion can be explained by a strongly activated outward-directed approach system (Rothbart, Ahadi, & Evans, 2000). The approach system would shorten the illusory aftereffect and, analogously, allow further information processing of the outer world, including one’s own behavior.

For the second pilot group, flying was experienced as a sufficient but not overpowering challenge. This seems to have been mirrored by their balance between intraceptive and extraceptive factors on the SAT.

In contrast, the third group of pilots included people with either long ( $H+$ ) or extremely short ( $LL$ ) aftereffects. These unbalanced reactions might be interpreted as reflecting a certain press in their work, since they had responsibilities as senior officers. Their complaints about rigid rules are in line with the wording by Rothbart et al. (2000): “positive anticipa-



tory tendencies may result in negative affect through the frustration or sadness resulting when an expectation is not met” (p. 126). It might be of interest that three pilots in this group got top rates from their superiors on both expertise and critical discernment, which no other pilot got. This difference is probably smaller than it would have been had all participants been rated against each other, and not against next higher grade.

### *Creativity*

Medium creative flexibility on the Creative Functioning Test was found in more than 60 % of the present group. When compared with a sample of 132 university teachers (Ryhammar & Smith, 1999), the present participants had a significantly higher share of medium creativity ( $\chi^2 = 10.89, p < .001$ ). This middle way implies a balance between what is realistic and what is not (Smith, 1995; cf. Ekvall, 1997). Medium creative flexibility could be described in terms of controlled imagination, which was actually described early on to distinguish a well-functioning pilot (Anderson, 1919). These creative realists (Moss Kanter, 1984) may be able to make implementations on the basis of pre-attentive cues. Similarly, contemporary aviation psychology emphasizes the necessity for good piloting to watch out even for small and oft-neglected risks (Besco, 1994). We conceive this to be affiliated with a neurophysiological orienting dimension, implying perceptual sensitivity (Rothbart, Ahadi, & Evans, 2000).

Although post-hoc, the questionnaire items relevant for the creative participants emphasized a wish for an individualistic position. This was most clearly recognized in the second ground officer cluster, having creative flexibility. This group did not focus on the family and like things, but instead described an urge to develop. These people might improve their creativity in another, less restricted context (cf. Smith & Carlsson, 1983).

### *Validity and limitations*

Validity in the cluster technique naturally depends on the selection of test instruments that are important for the investigated system (Magnusson, 1999). In the present investigation the test-based cluster solutions formed meaningful patterns that agreed with previous research. Furthermore, these clusters got a face validity support from the participants' attitudes to their

work. For example, a majority of the pilots in the first group expressed feelings of insufficiency, and were found in a subsequent analysis to be younger than the other pilots.

The more general applicability of the results depends in part on how representative the selected officers were of military staff. The pilots included practically all the flying personnel at the unit, and should therefore be regarded as more representative than the small and select group of ground officers. Probably a randomised sample of ground officers would have resulted in groups that had partly different characteristics. Also, the ground officer group was younger and not properly matched to the pilots. Thus it is necessary to under build the results in this study, found with exploratory techniques, with further, hypothesis-testing research.

A final question could be raised about to what extent the clusters were the outcome of stable personality structures, or if they were influenced by the participants' present context. Interaction effects seem probable. Quite generally, "persons qualify trait descriptions of themselves by specifying under what particular situations a general disposition is likely to influence their behavior" (McAdams, 1992, p. 347). For instance, in this study the pilots as a group had a relatively stable hold when pressed. But this did not exclude that those with leadership tasks showed signs of tension, and moreover expressed frustration at their work. Conceivably, adaptation to strain is a dynamic balance not only between systems of affective reactivity and cognitive control, but also including the external pressures that influence these internal systems (cf. Mischel & Shoda, 1999). We believe that further descriptions and validations of such interactions/personality patterns, are important in future investigations. In the future it is also of interest to complement the behavioral process tests with questionnaires construed to tap these same personality dimensions, as well as with biological markers.

## **ACKNOWLEDGMENTS**

For statistical expertise we wish to thank Göran Linde (deceased). Tord Karlsson, head of the wing at that time, is thanked for kindly supporting the investigation. Maj Lantz is acknowledged for efficient secretarial help.

Alf Ingesson-Thor, Olof Rydén and Bert Westerlundh are thanked for valuable advice.

## REFERENCES

- Alkov, R. A., Gaynor, J. A., & Borowsky, M. S. (1985). Pilot error as a symptom of inadequate stress coping. *Aviation, Space, and Environmental Medicine, March*, 244-247.
- Amabile, T. (1983). *The Social Psychology of Creativity*. New York: Springer Verlag.
- Amnér, G. (1997). Fear of flying in civil airline passengers. A manifold phenomenon with various motivational roots. *Doctoral dissertation, Lund University*, Lund, Sweden: Studentlitteratur.
- Anderson, H. G. (1919). The psychology of aviation. In *The Medical and Surgical Aspects of Aviation*, London: Oxford University Press.
- Andersson, A. L. (1969). Adaptive regulation of visual after-effect duration and social-emotive adjustment. *Acta Psychiatrica*, 29:1-34.
- Andersson, A. L. (1972). Personality as reflected in adaptive regulation of visual aftereffect perception: A review of concepts and empirical findings. In: *Visual Aftereffects and the Individual as an Adaptive System*, eds. A.L. Andersson, A. Nilsson, E. Ruuth, & G.J.W. Smith. Lund: Gleerup, pp. 159-171.
- Andersson, A. L. (1995). *Spiral Aftereffect Technique*. Department of Applied Psychology, Lund University, Sweden.
- Andersson, A. L., Almgren, P – E., Engleson, I., Smith, G.J.W., Smith, M., & Uddenberg, G. (1984). Personlighet och moderskap. (Personality and motherhood. Women's emotional reactions and social context in connection with childbirth related to the personality and the children's personality 7 – 8 years later). *Research Report 3, Department of Applied Psychology*, Lund University, Lund, Sweden.
- Andersson, A. L. & Bengtsson, M. (1985). Percept-genetic defenses against anxiety and a threatened sense of self as seen in terms of the Spiral Aftereffect Technique, *Scandinavian Journal of Psychology*, 26:123-139.

- Bachelor, P., & Michael, W.B. (1991). Higher-order factors of creativity within Guilford's structure-of-intellect model: A re-analysis of a fifty-three variable data base. *Creativity Research Journal*, 4(2):157-175.
- Barron, F. (1988). Putting creativity to work. In: *The Nature of Creativity*, ed. R.J. Sternberg. Cambridge: Cambridge University Press.
- Bartram, D. (1995). The predictive validity of the EPI and 16PF for military flying training. *Journal of Occupational and Organizational Psychology*, 68:219-236.
- Bartram, D. & Dale, H. C. A. (1982). The Eysenck personality inventory as a selection test for pilots. *Journal of Occupational Psychology*, 55:287-296.
- Besco, R. O. (1994). The potential contributions and scientific responsibilities of aviation psychologists. In: *Aviation Psychology: Training and Selection*, eds N. Johnston, R. Fuller, & N. McDonald. European Association for Aviation Psychology, Brookfield, Ver.: Ashgate Publishing Company.
- Brown, J. (1991). *Self as Process*. New York: Springer Verlag.
- Carlsson, I. (1992). The creative personality. Hemispheric variation and sex differences in defence mechanisms related to creativity. *Doctoral dissertation, Lund University*, Lund, Sweden: Studentlitteratur.
- Carlsson, I., Wendt, P. E., & Risberg, J. (2000). On the neurobiology of creativity. Differences in frontal activity between highly and low creative subjects. *Neuropsychologia*, 38:873-885.
- Cattell, R. B., Eber, H.W., & Tatsouka, M. (1970). *Handbook for the Sixteen Personality Factor Questionnaire (16PF)*. Institute for Personality and Ability Testing, Champaign, Il.
- Clark, L.A., & Watson, D. (1999). Temperament: A new paradigm for trait psychology. In: *Handbook of Personality: Theory and Research*, 2<sup>nd</sup> ed, eds L. A. Pervin & O.P. John, New York: The Guilford Press.
- Crutchfield, R. S. (1964). Conformity and creative thinking. In *Contemporary Approaches to Creative Thinking*, eds H. E Gruber, G. Terrell, & M. Wertheimer. New York: Atherton Press.
- Ekvall, G. (1991). The organizational culture of idea-management: a creative climate for the management of ideas. In: *Managing Innovation*, eds J. Henry & D. Walker, Sage.

- Ekvall, G. (1997). Organizational conditions and levels of creativity. Paper presented at the *Eight European Congress on Work and Organizational Psychology*, Verona, Italy.
- Everitt, B. E. (1980). *Cluster Analysis*, 2<sup>nd</sup> ed. London: Heineman Educ. Books Ltd.
- Eysenck, H. J. (1959). *Manual of the Maudsley Personality Inventory*, London: University of London Press.
- Eysenck, H. J. (1967). *The Biological Basis of Personality*. Springfield, IL.: C.C. Thomas.
- Eysenck, H. J. (1995). *Genius: The Natural History of Creativity*. Cambridge: Cambridge University Press.
- Gray, J. A. (1970). The psychophysiological basis of introversion-extraversion. *Behaviour Research and Therapy*, 8:249-266.
- Hanlon, R.E. (1991). *Cognitive Micro-Genesis: A Neuropsychological Perspective*. New York: Springer Verlag.
- Jessup, G., & Jessup, H. (1971). Validity of the Eysenck personality inventory in pilot selection. *Journal of Occupational Psychology*, 21:158-169.
- John, O.P. (1989). Towards a taxonomy of personality descriptors. In: *Personality Psychology: Recent Trends and Emerging Directions*, eds D. M. Buss & N. Cantor. New York: Springer Verlag, pp. 261-271.
- Jönsson, P., & Carlsson, I. (2000). Androgyny and creativity: A study of the relationship between a balanced sex-role and creative functioning. *Scandinavian Journal of Psychology*, 41:269-274.
- Karasek, R. A., & Theorell, T. (1990). *Healthy Work, Stress, Productivity, and the Reconstruction of Working Life*. New York: Basic Book.
- Klecka, W. R. (1980). *Discriminant Analysis*. University paper series on quantitative application in the social sciences. London: Sage Publications.
- Kragh, U., & Smith, G. J. W. (1970). *Perceptgenetic Analysis*. Lund, Sweden: Gleerups.
- Kyriazis, D.A. (1991). *Personality aspects in aircraft accidents*. Paper presented at the Air Forces Flight Safety Committee Europe, 112<sup>th</sup> Meeting, Athens, 16 - 18 Oct.
- Lazarus, R.S., & Folkman, S. (1984). *Stress, Appraisal and Coping*. Springer Verlag, New York.

- Levi, L. (1981). *Society, Stress and Disease – Working Life, IV*, Oxford: Oxford University Press.
- Magnusson, D. (1999). Holistic interactionism: A perspective for research on personality development. In: *Handbook of Personality: Theory and Research*, 2<sup>nd</sup> ed., eds L. A. Pervin & O.P. John. New York: The Guilford Press, pp 219-247.
- Magnusson, D. & Törestad, B. (1993). A holistic view of personality: A model revisited. *Annual Review of Psychology*, 44:427-452.
- McAdams, D.P. (1992). The five-factor model in personality: A critical appraisal. In: *The five-factor model: Issues and applications*, ed. R.R. McRae. *Journal of Personality*, 60, 2:329-361.
- Mischel, W., & Shoda, Y. (1999). Integrating dispositions and processing dynamics within a unified theory of personality: The cognitive – affective personality system. In: *Handbook of Personality: Theory and Research*, 2<sup>nd</sup> ed., eds L. A. Pervin & O.P. John. New York: The Guilford Press, pp. 197-218.
- Moss Kanter, R. (1984). *The Change Masters. Cooperate Entrepreneurs at Work*. London: George Allen & Unwin.
- Okaue, M., Nakamura, M., & Nira, K. (1977). Personality characteristics of pilots on EPPS, MPI and DOSEFU. *Reports of Aeromedical Laboratory*, 18:83-93.
- Pickering, A.D., & Gray, J.A. (1999). The neuroscience of personality. In: *Handbook of Personality: Theory and Research*, 2<sup>nd</sup> ed., eds L. A. Pervin & O.P. John. New York: The Guilford Press, pp. 277-299.
- Reinhardt, R. (1970). The outstanding jet pilot. *American Journal of Psychiatry*, 127:732-736.
- Rothbart, M.K., Ahadi, S.A., & Evans, D.E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology*, 78(1):122-135.
- Ryhammar, L., & Smith, G.J.W. (1999). Creative and other personality functions as defined by percept-genetic techniques and their relation to organizational conditions. *Creativity Research Journal*, 12(4):277-286.
- Schoon, I. (1992). *Creative Achievement in Architecture*. Leyden, Holland: DSWO Press.

- Shipley, P., & Orlans, V. (1988). Stress research: An interventionist approach. In: *Occupational Stress. Issues and Developments in Research*, eds J. J. Hurrell et al. New York: Taylor and Francis.
- Smith, G. J. W. (1995). How can middle-range creativity be useful? *The Second Int. Conference on the Military Applications of Synthetic Environments and Virtual Reality*. Stockholm: Försvarets Materielverk.
- Smith, G. J. W. & Carlsson, I. (1983). Creativity and anxiety: An experimental study. *Scandinavian Journal of Psychology*, 24:107-115.
- Smith, G. J. W. & Carlsson, I. (1990). The creative process: A functional model based on empirical studies from early childhood to middle age. *Psychological Issues*, 57, Madison, Conn.
- Smith, G. J. W. & Carlsson, I. (2001). *CFT – a Test of Creative Functioning*. Lund: Department of Psychology.
- Smith, G. J. W., Nyman, G. E., Hentschel, U., & Rubino, I. A. (2001). *S-CWT: The Serial Color Word test. Manual*. Frankfurt: Swets & Zeitlinger.
- Tempereau, C. E. (1956). Fear of flying i Korea. *American Journal of Psychiatry*, 113:218 – 223.
- Thurstone, L. L. (1944). *A Factorial Study of Perception*. Chicago: University of Chicago Press.