

THE PSYCHOMETRIC PROPERTIES OF OAD (TRAIT) - UK

A STUDY UNDERTAKEN BY ORGANISATIONAL SOLUTIONS
JANUARY 2000

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1. INTRODUCTION

1.1 Background to project

In November 1999, OAD LLC retained Organisational Solutions, a UK-based occupational psychology consultancy, to undertake an objective and comprehensive review of the company's principal psychometric product, the OAD (Organisation Analysis and Design). This review involved ascertaining the psychometric properties of the instrument, i.e. its reliability and validity.

Organisational Solutions' Managing Director, Paul Brewerton, undertook the work over an 8 week period and this document represents the project's findings.

1.2 Organisational Solutions: Statement of capability

Organisational Solutions' principals are Paul Brewerton BA (Hons), MA, MSc, C.Psychol (Occup) (Managing Director) and Dr Lynne Millward BA, C.Psychol (Occup), AFBPS (Strategic Consultant). Trading informally since 1997, and as a legal entity since early 1999, the company works principally in the areas of employee surveys, organisational development and change, recruitment and selection practice, and psychometric validation.

To date, Organisational Solutions has developed/validated a series of psychometrically-robust instruments which are now in wide academic and/or commercial use, including the Performance Culture Audit (culture/climate survey), the Corporate Communications Audit, the Psychological Contract Scale (related findings published in the Journal of Applied Social Psychology and British Journal of Management), the Integrity at Work Tool (a personality-based selection instrument), and the Telebusiness Psychometric Inventory (a personality-based selection instrument designed for use in the call-centre industry). Paul Brewerton submitted a doctoral thesis in July 1999 employing a range of psychometric techniques to investigate the relationship between the perceived delivery of the 'employment deal' and psychological outcomes for employees. Paul Brewerton is Level 'A' and Intermediate Level 'B' qualified and is retained by the publishing house NFER-Nelson as an associate trainer, running public and in-house Level 'A' and 'B' courses on their behalf.

1.3 Summary of analyses/techniques employed during project

When administering any questionnaire-based instrument, the user needs to be sure that the tool is actually able to measure what it purports to measure (i.e. it is **valid**) and that it is consistent over time and across the domain of interest (i.e. it is **reliable**). A number of statistical and other techniques are available to allow test developers to infer the relative levels of reliability and validity of their instrument, and thus describe its underlying psychometric properties.

For selection-based instruments such as OAD (Trait), the following psychometric properties are generally regarded as crucial (Kline, 1998):

- The scales which purport to tap into each dimension of interest (e.g. extroversion, creativity) cover each dimension comprehensively, using items which are agreed to be relevant and consistent by subject matter experts (this is referred to as **content validity**);
- Each of the instrument's dimensions reports statistical independence from each other dimension, and demonstrates a statistical relationship with existing scales as appropriate (**construct validity**);
- There exists a relationship between key dimensions of the instrument and 'real world' criteria of interest, e.g. individual work performance (**criterion validity**);
- Finally, each dimension should report high internal consistency and should be stable over time (**reliability**).

The following methods for ascertaining OAD (Trait)'s reliability and validity are described within this document:

Content validity

- Development of a large item pool, piloted with subject matter experts (SMEs);
- Adapting (in terms of language and content), selecting and deselecting items until SME panel is satisfied;
- Piloting initial item pool with respondents to remove problematic items.

Construct validity

- Making explicit links between OAD (Trait) dimensions and scales from existing personality-based instruments;
- Assessing the independence of scale dimensions using factor analytic techniques.

Criterion validity

- Assessing statistical relationships between scale dimensions and target criteria using correlational analysis.

Reliability

- Calculating internal consistency reliability for each scale dimension, using Cronbach's alpha criterion and split-half reliability testing.

1.4 Data provided to Organisational Solutions

The data provided to Organisational Solutions during the course of the project were as follows:

- OAD Management Seminar Manual;
- Original UK dataset (comprising questionnaire data from 2,842 respondents);
- Research data comparing OAD (Trait) with NEO (comprising questionnaire data from 134 respondents);
- Research data using OAD (Trait) and the Pressure Management Indicator (Cooper and Williams, 1996) (comprising data from 124 respondents);
- Summary data from UK dataset (N=250), including scale means/standard deviations, summary factor analytic data, correlation matrix comprising 16-PF and OAD (Trait) scales, internal consistency reliability figures for all scales;
- Summary data from three criterion-related validation studies run with US and Canadian employee samples.

1.5 Introduction to the OAD

The OAD (Organisation Analysis and Design) is an adjective-based selection, development and information-gathering instrument comprising two matched questionnaires. Each questionnaire contains 110 adjectives. For the first set of 110 adjectives, respondents are asked to tick those words which best describe themselves and to leave unticked items which do not describe them. For the second set of 110 items, respondents are asked to tick those words which describe how they must behave in their current (or previous) job.

Both questionnaires are reported to comprise six distinct scales, defined (according to the OAD Management Seminar Manual) below:

- **Assertiveness/Autonomy:** independence, need for control, self-confidence, resourcefulness;
- **Extraversion:** degree of social and people orientation guiding a person's behaviour;
- **Patience:** degree to which individual needs system and predictability, degree of patience, need for variety;

- **Detail-orientation:** concern for correctness, orderliness and structure, including sense of duty;
- **Emotional Control:** extent to which individual exercises control over emotions and actions;
- **Creativity:** degree of inventiveness and originality of thinking.

In addition, scores on the first four scales (Assertiveness/autonomy, Extraversion, Patience and Detail-orientation) are summed to produce a cumulative score, termed **‘Versatility Level’**. Versatility is regarded as an indicator of behavioural flexibility, with higher scores indicating more flexible individuals who are willing to step outside of their ‘comfort zone’ and who are better equipped to ‘bounce back’ following periods of insecurity and experienced stress.

Each of the six principal scale scores is obtained by summing the number of ticked items for that particular scale. This scale score is standardised by comparison with the total UK dataset (N=2,842) and conversion to percentile score. Percentile scores are plotted on a software-generated graph according to decile position (ranging from 0-10). The Versatility score is not standardised but is reported on the graph at the mean decile position between the first four scales. An example output graph appears as Figure 1, below:

Figure 1: Example OAD (Trait) output graph

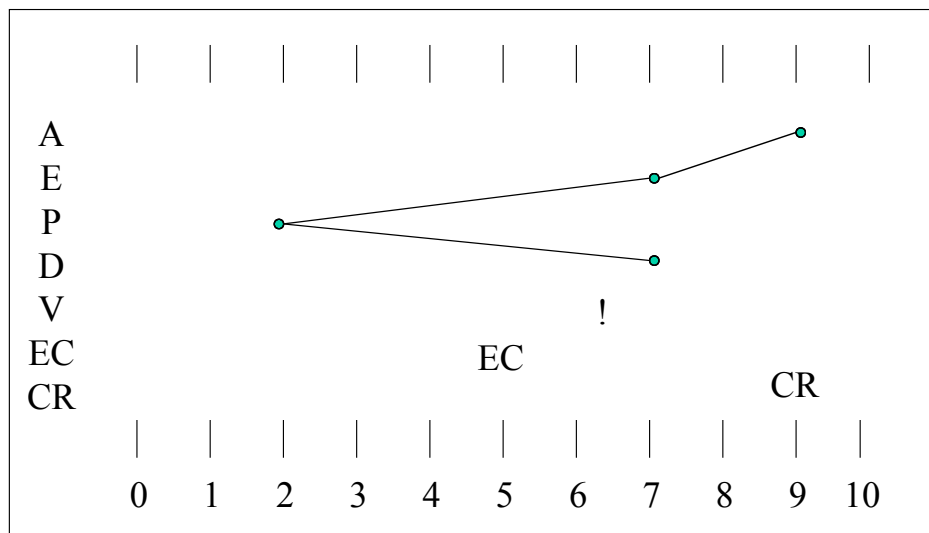


Figure 1 demonstrates that the respondent reports a 9th decile on Assertiveness/Autonomy, a 7th decile on Extraversion, a 2nd decile on Patience and a 7th decile on Detail-orientation. The position of the Versatility Level score (represented by the ‘!’ character) denotes the mean decile value on summing these four scale scores. The respondent also reports a 5th decile on Emotional Control and a 9th decile on Creativity.

The OAD describes the first four scale scores in terms of their *relative* position when compared against each other, using the Versatility Level score as a ‘marker’ of the midpoint of the distribution. Thus, for the above respondent, Assertiveness/autonomy and Patience appear as the most marked characteristics, representing the extremes of the distribution (the 9th and 2nd deciles respectively), with Extraversion and Detail-orientation taking up less extreme positions [and therefore, according to Gray (1997) likely to be less demonstrably marked in the individual’s trait profile]. The Emotional Control and Creativity scales are reported as decile scores only and are reported in isolation.

Similar calculations are undertaken with the second of OAD's two component questionnaires, with obtained scores compared with the UK dataset (N=2,842) in order to produce percentile and then decile scores. Scores are plotted on a similar graph to that shown above.

The user is provided with a series of outputs having input an individual's response data into the OAD software:

- Output graphs (similar to that shown above) for both 'Traits' and 'Perceived Job Behaviours';
- A summary of the individual's trait profile;
- A summary of potential motivating needs for that individual;
- A summary of perceived job behaviours.

These data are intended for application by the user in a number of ways:

- Use of OAD as one 'diagnostic' for management and/or organisation development activities;
- Use of OAD Trait and Perceived Job Behaviours Output as a basis for individual development, by comparing the two sets of data. Where differences in the profiles appear, it is likely that the individual perceives a need to change/develop in order to perform their current role more effectively;
- Use of both sets of output to identify individuals who may feel 'under- or over-utilised' in their present positions and to inform subsequent discussions regarding more suitable roles for those individuals;
- Use of the Perceived Job Behaviours output to gather data on a particular job role/position, particularly during the initial data gathering phase of a job analysis.
- Use of OAD Trait output alone to inform the recruitment/selection process, particularly in forming a basis for subsequent interview;

Please note that the current report represents an investigation into the psychometric properties of the OAD (Trait) instrument alone, and does not explore the OAD (Perceived Job Behaviours) instrument from a psychometric perspective.

2. CONTENT VALIDITY

Over the period 1987-1990, Michael Gray, Managing Partner of OAD LLC, a Boston-based consulting firm, developed, refined and validated the OAD Instrument over four major administration sessions drawing on over 1,000 US participants.

Based on over 20 years' experience of consulting in the Human Resources field, Gray (a Quantitative Analysis M.A. from Syracuse University) resolved to develop an adjectivally-based selection and development instrument which was aimed to improve on existing personality instruments in the following areas:

- Speed of completion;
- Reducing error through use of adjectivally-anchored inventory;
- Providing an indication of the respondent's 'fit' with their current job role in order to identify possible current and future problems for individuals, teams and departments.

Gray based the development of his initial item pool on the research underpinning McRae and Costa's (1987) research into a five-factor model of personality, and on Cattell's extensive research into personality (e.g. Cattell, Eber and Tatsuoka, 1970). Drawing on his own knowledge of the world of work, as well as on the above research, Gray developed a pool of around 250 adjectives which he felt tapped into those elements of personality most critical to success at work. Having run various pilot sessions with colleagues to ensure accessibility and comprehensibility of items, and to ensure that the domains covered by the items were as comprehensive as possible, Gray undertook a four-year validation programme with the OAD (Trait). This validation programme involved four major administrations of the OAD (Trait) instrument to over 1,000 US respondents between 1987 and 1990 (with samples numbering 110, 289, 413 and 234 cases, evenly split for gender) and saw the original 250-strong item pool reduced to 110 items through iterative factor and item analysis. A construct validation exercise during this period also saw the OAD (Trait) administered concurrently with the 16-PF instrument to explore relationships between component scales.

The six-factor instrument that emerged in 1990 had thus been derived on a largely empirical basis from extensive factor and item analysis, with a sound basis in personal experience and in the published work of major personality theorists such as Cattell and Costa and McRae.

While relationships between the six OAD (Trait) factors (introduced in Section 1.5, above) and those included in Cattell's 16-PF series, and Costa and McRae's NEO series are apparent (both intuitively and statistically – see Section 4, below, for details on the statistical relationships between OAD's and these instruments' component scales), Gray incorporated an additional scale, 'Versatility Level', rarely seen in personality research. The Versatility Level scale was calculated by simple summation of the Assertiveness/Autonomy, Patience, Extraversion and Detail-orientation scales and was intended to provide an overall indication of the behavioural flexibility and "general activity level" exhibited by each respondent. Based largely on his own experience of work, Gray believed that the level of 'Versatility Level' exhibited by the individual could have a significant effect on experienced stress at work, acting as a buffer or coping mechanism when the individual was required to undergo a period of transition or insecurity. This proposition has been researched by Gray on a small scale, using a stress indicator measure, with some encouraging results (see Section 4.5 for more details).

3. RELIABILITY

Internal consistency reliability analyses were carried out with the UK dataset (N=2,842) using both Cronbach's alpha criterion and corrected split-half reliability estimates, for OAD (Trait). US results were made available from OAD LLC's training manual (but were not derived from the original dataset), and draw on a sample size of 234. UK results appear in Table 1, below.

Table 1: Internal consistency reliability estimates for the six principal scales of OAD (Trait) for US (n=234) and UK (n=2842) dataset

	Number of items	Sample size (N)	Cronbach's Alpha (US)	Cronbach's Alpha (UK)	Corrected split-half (UK)
Assertiveness	17	2842	.838	.835	.841
Extraversion	16	2842	.812	.793	.782
Patience	13	2842	.771	.687	.664
Detail-orientation	22	2842	.832	.814	.793
Emotional control	18	2842	.828	.695	.735
Creativity	16	2842	.879	.823	.837

All scales exceed the minimum of .7 suggested by Nunnally (1978) and Kline (1986; 1993b; 1994) other than the Patience scale (for the UK dataset). It is possible that the length of the Patience scale compared with the length of other component scales contributes to the lower reliability estimate for this scale.

Research planned by OAD LLC (see Section 6) intends to address and resolve the low reliability estimate of the Patience scale by incorporating new and revised items in future editions of the OAD (Trait) instrument.

4. CONSTRUCT VALIDITY

4.1 Introduction

Demonstration of construct validity is crucial in ensuring the theoretical and empirical robustness of a psychometric instrument's component dimensions. A number of techniques are available for the investigation of a personality instrument's construct validity, most notably conducting correlational studies with well-established measures of personality, and investigating the internal factor structure of the instrument via factor analytic methods.

By making explicit links between OAD (Trait) dimensions and scales from existing personality-based instruments, evidence may be obtained as to the degree to which the OAD (Trait) is tapping into 'target' constructs. For example, by correlating OAD (Trait)'s 'Extraversion' and 'Detail-orientation' dimensions with scales in alternative personality questionnaires which purport to assess similar constructs, it is possible to assess the degree of convergence (similarity) and divergence (dissimilarity) in these relationships. Where an expected *a priori* relationship between scales is actually obtained, this provides evidence for convergent validity. Where two scales are not expected to report a significant relationship and this zero relationship is reported, evidence for divergent validity is obtained.

Examining the internal structure of a psychometric instrument is also crucial to ensure that the component dimensions of the instrument are measuring *independent* constructs. Without this independence, it is possible that scale dimensions are tapping into the same, or very similar, constructs, thus reducing the utility of the scales. This is most often achieved using factor analytic techniques, which allow exploration of the correlational relationships between all items within a psychometric instrument, to identify those items which 'cluster' together, suggesting the presence of a single underlying construct.

4.2 Relationships between OAD and existing measures of personality

4.2.1 OAD (Trait) and 16-PF

Two major studies have been undertaken by OAD Inc to investigate the relationships between OAD (Trait)'s component scales and those of existing personality instruments. The first of these saw administration of both OAD (Trait) and 16-PF (Form C, 1978) to 250 UK participants in October-November 1999. Four of 16-PF's 16 component dimensions did not produce significant correlations and are excluded from the table, with the remaining 12 dimensions as follows:

- **A (Warmth)** – interest in, and readiness to become warmly involved with, others;
- **E (Dominance)** – degree to which an individual imposes his/her will on others;
- **F (Liveliness)** – degree to which an individual gives free rein to impulses;
- **G (Rule consciousness)** – willingness to accept and follow externally-imposed rules of conduct;
- **H (Social boldness)** – degree to which an individual feels at ease in social situations;
- **I (Sensitivity)** – degree to which an individual is sensitive; insecurity;
- **L (Vigilance)** – degree to which an individual questions motives of others;
- **M (Abstractedness)** – focus of attention when taking in information; creativity;
- **Q1 (Openness to change)** – openness to new experiences and new ways of doing things;
- **Q2 (Self-reliance)** – degree to which an individual prefers to make choices and decisions independently of others;
- **Q3 (Perfectionism)** – degree to which an individual plans ahead and behaves in an orderly and consistent manner;
- **Q4 (Tension)** – level of physical tension experienced.

Pearson's Product Moment Correlational analyses between each of OAD (Trait)'s 6 component scales and the 11 16-PF scales are summarised in Table 2, below. Please note that only those correlations exceeding $p=.001$ are included in the table for the sake of clarity.

Table 2: Correlational analysis – OAD and 16-PF (n = 250)

16PF4 scale	A	E	P	D	EC	CR
A (Warmth)		.383				
C (Emotional stability)	NA	NA	NA	NA	NA	NA
E (Dominance)	.449					.323
F (Liveliness)		.498				
G (Rule consciousness)				.259		
H (Social boldness)	.579	.318	-.227			.299
I (Sensitivity)					.438	
L (Vigilance)						
M (Abstractedness)						.657
N (Privateness)	NA	NA	NA	NA	NA	NA
O (Apprehension)	NA	NA	NA	NA	NA	NA
Q1 (Openness to change)	.309					.552
Q2 (Social Approval)		.496				
Q3 (Controlled)				.312	.403	
Q4 (Tension)			-.401			

To summarise these findings,

- OAD Assertiveness/Autonomy ('A') is significantly correlated with 16-PF's Dominance, Social boldness and Openness to change factors. Construct validity for this factor, then, can be inferred from the study findings;
- OAD Extraversion ('E') correlates significantly with 16-PF's Warmth, Liveliness, Social boldness and Self-reliance factors. Interestingly, these are precisely the factors used by NFER-Nelson (publishers of the 16-PF series) to calculate the global factor of 'Extraversion' (along with Privateness, which was not included in the above study). This provides excellent evidence for the discriminant and convergent validity of OAD's 'E' dimension.
- OAD Patience ('P') significantly correlates with 16-PF's Social boldness (negative loading), suggesting that those respondents reporting high 'Patience' scores are less likely to feel at ease in social situations. The OAD 'P' also loads negatively on 16-PF's Tension factor, an expected relationship.
- OAD Detail-orientation ('D') correlates significantly with 16-PF's Rule-consciousness and Perfectionism factors. This is in line with *a priori* expectations since these factors address traits such as meticulousness, forward planning and self-discipline. Good evidence, then, is found for OAD 'D's convergent and discriminant validity with 16-PF.
- OAD Emotional Control ('EC') correlates significantly with 16-PF's Sensitivity factor. This is in line with expectations since these factors address traits such as tough- and tender-mindedness and logical evidence vs. sensitive intuition. This construct also correlates significantly with the Perfectionism factor. This makes some intuitive sense

since several of the ‘EC’ items address self-discipline, distractibility, absent-mindedness, etc.

- OAD Creativity (‘CR’) correlates significantly with 16-PF’s Dominance, Social boldness, Abstractedness and Openness to change. Relationships with Abstractedness and Openness to change are in line with expectations, since these dimensions address creativity of thinking and openness to new ideas. However, the significant relationships with Dominance and Social boldness undermine the divergent validity of OAD’s ‘CR’ dimension to some extent. *Note: Gray points out that dominance and creativity inter-correlate, as they do on Cattell’s 16PF and other regarded instruments).*

Please see Section 4.2.3, below, for a brief assessment of the implications of these findings for OAD (Trait).

4.2.2 OAD and NEO-FFI

The second major correlational study commissioned by OAD Inc (November 1999) saw 134 UK participants complete OAD (Trait) and NEO-FFI. All five of the NEO’s component dimensions were included in the study, as follows:

- **Neuroticism** – anxiety, hostility, self-consciousness, impulsiveness, vulnerability;
- **Extraversion** – warmth, gregariousness, assertiveness, activity, excitement-seeking;
- **Openness** – fantasy, feelings, actions, ideas, values;
- **Agreeableness** – trust, straightforwardness, altruism, compliance, modesty;
- **Conscientiousness** – competence, order, dutifulness, achievement-striving, self-discipline.

Pearson’s Product Moment Correlational analyses between each of OAD (Trait)’s 6 component scales and the 5 NEO scales are summarised in Table 3, below. These findings derive from a summary dataset provided to Organisational Solutions which contained dimensional means for both NEO-FFI and OAD (Trait). Please note that only those correlations exceeding $p=.01$ are included in the table for reasons of clarity.

Table 3: Correlational analysis – OAD (Trait) and NEO-FFI

NEO scale	A	E	P	D	EC	CR
Neuroticism	-.35				-.30	
Extraversion	.40	.54				
Openness						.25
Agreeableness			.25			
Conscientiousness				.43		

To summarise these findings,

- OAD Assertiveness/Autonomy (‘A’) loads as expected on the NEO’s Neuroticism and Extraversion factors. The OAD ‘A’ scale contains components of both NEO’s Extraversion (e.g. assertiveness, positive emotions) and Neuroticism (lack of anxiety, lack of vulnerability). The non-significant loadings of OAD ‘A’ on Openness, Agreeableness and Conscientiousness are also to be expected and demonstrate OAD ‘A’’s discriminant validity.
- OAD Extraversion (‘E’) loads, as expected, on NEO’s Extraversion factor. OAD ‘E’ demonstrates its convergent validity by failing to load significantly on any other of the NEO’s five factors.

- OAD Patience loads on NEO's Agreeableness factor only. Again, this is to be expected since both scales address such traits as straightforwardness, trust and compliance.
- OAD Detail-orientation loads solely on NEO's Conscientiousness scale, demonstrating good convergent validity on traits such as self-discipline, meticulousness and competence.
- OAD Emotional Control ('EC') loads negatively on NEO's Neuroticism factor, demonstrating good convergent validity on traits such as attention seeking and self-indulgency.
- Finally, OAD Creativity ('CR') loads positively on NEO's Openness factor. This is expected, since OAD 'CR' is closely related to NEO's Openness factor. This demonstrates convergent validity of the OAD 'CR' scale.

4.2.3 Summary of correlational studies' findings

To summarise findings from these studies, excellent evidence for discriminant (convergent and divergent) validity of the OAD (Trait)'s Extraversion, Detail-orientation, and Emotional Control, and Creativity factors was obtained. Good evidence for construct validity was apparent for OAD (Trait)'s Autonomy/Assertiveness and Patience dimensions.

4.3 Factor structure of OAD (Trait): UK dataset

4.3.1 Introduction to factor analysis

Factor analytic techniques can be used to explore the underpinning structure of items comprising a psychometric instrument such as OAD (Trait). In simple terms, these techniques are able to assess correlational relationships between all items within an instrument, thereby determining which items 'cluster' together most strongly. In this way, the relative independence of the component dimensions making up a personality instrument such as OAD (Trait) may be assessed, as can relationships between these dimensions.

In order to conduct factor analysis, the sample dataset must demonstrate a number of key characteristics:

1. The sample should be as heterogeneous as possible (Kline, 1993a);
2. The sample should match as closely as possible the target population for which the instrument is intended, in this case the UK adult population (Kline, 1997);
3. Sample size must be large enough to reduce standard error of correlations to negligible proportions. An absolute minimum acceptable sample size is widely regarded as 100 with 200+ preferable (Kline, 1993a, 1997);
4. Subject: item ratio requires a 3:1 relationship between respondents and the number of items included in a study. In the case of OAD (Trait)'s 110 items, a minimum sample size of 336 respondents would thus be required from any one sample (Barrett and Kline, 1981);

4.3.2 Suitability of the dataset for factor analytic techniques

Using the entire UK dataset (n=2842), all of the requirements for factor analysis are upheld. The dataset is heterogeneous, comprising 63% males and 10 occupational groups including salespeople (n=289), clerical staff (n=230), production staff (n=425), etc. The sample size (2842) significantly exceeds both the minimum preferable size required for factor analysis (200) and the required size to exceed the subject: item ratio (336).

A principal components factor analytic procedure was selected due to the size and complexity of the correlation matrix underpinning the OAD (Trait). A Scree test suggested the extraction of 6 items, a minimum eigenvalue analysis suggested extraction of 8 items. Given *a priori*

expectations (for the presence of six factors), in addition to the Scree test findings, six factors were rotated to simple structure using an oblique method (Direct Oblimin), which does not assume orthogonality (independence) of factors. The structure, rather than the pattern, matrix was used to interpret findings since the structure matrix reports correlational relationships rather than beta weights. Any factor loadings exceeding .28 are reported in the Table 4, below (this minimum criterion was used due to the likely significance of correlations falling below the generally acceptable level of .30), which shows the structure matrix for the analysis.

Table 4: Structure matrix for principal components factor analysis of OAD (Trait) conducted with UK dataset (N=2842), rotated to a 6-factor simple structure via direct oblimin

Item	Factor 1 (Assert's/ Creativ'y)	Factor 2 (Emotion'l Control)	Factor 3 (Detail)	Factor 4 (Extrav'n)	Factor 5 (Patience)	Factor 6 (NA)
A1	.495		.282			
A2	.456		.369			
A3	.397		.379			
A4	.430					
A5	.443					
A6	.506					
A7	.510			-.288		
A8	.428			-.340		
A9	.437			-.322		
A10	.464					
A11	.554		.284	-.290		
A12	.427		.314	-.308		
A13	.527					
A14	.509			-.299		
A15	.306	.304				
A16	.542		.335			-.337
A17			.385			
C1	.520					
C2	.492					
C3	.302					-.359
C4	.558					-.333
C5	.467					
C6	.552			-.295		
C7	.481					-.313
C8	.391			-.456		
C9	.590					
C10	.675					
C11	.504		.346			
C12				-.329		
C13	.633					

Item	Factor 1 (Assert's/ Creativ'y)	Factor 2 (Emotion'l Control)	Factor 3 (Detail)	Factor 4 (Extrav'n)	Factor 5 (Patience)	Factor 6 (NA)
C14				-.471		
C15		.338				
C16	.447		.314			
D1	.385		.308			
D2			.571			
D3			.494	-.292		
D4			.388			-.433
D5			.347			
D6			.365		-.332	
D7			.526			
D8			.574			
D9			.608			
D10		.346				
D11			.342		-.351	
D12			.296			-.294
D13			.664			
D14		.597				
D15		.358	.291			
D16			.594			
D17			.488			
D18	.292		.425			
D19	.414		.464			
D20			.337	-.337		
D21			.316			
D22			.284			
E1				-.401		
E2	.308			-.375		
E3				-.573		
E4				-.401		
E5				-.629		
E6				-.565		
E7			.300	-.378		-.356
E8				-.588		
E9				-.548		
E10		.332		-.406		
E11				-.471		
E12	.307					
E13				-.454		
E14				-.421		.284
E15				-.596		
E16						

Item	Factor 1 (Assert's/ Creativ'y)	Factor 2 (Emotion'l Control)	Factor 3 (Detail)	Factor 4 (Extrav'n)	Factor 5 (Patience)	Factor 6 (NA)
EC1		.412				
EC2					-.411	
EC3						
EC4		.398				
EC5		.581				
EC6						
EC7		.411				
EC8		.429				
EC9		.355				
EC10				-.343		-.380
EC11		.512				
EC12		.494				
EC13		.479				
EC14		.411				-.299
EC15		.409				
EC16		.363				
EC17		.366				
EC18		.588				
P1				-.335	-.489	
P2					-.486	
P3				-.346	-.429	
P4					-.464	
P5					-.464	
P6					-.475	
P7					-.483	
P8					-.451	
P9	.321		.352			
P10					-.347	-.448
P11	.383		.409			
P12			.594			-.333
P13					-.416	

This principal components, obliquely rotated (Direct Oblimin) forced 6-factor solution, explains 30.28% of the total variance. Converging in 24 iterations, Factor 1 (eigenvalue = 12.36) explains 12.1% of the variance, Factor 2 (eigenvalue = 5.55) explains 5.45% of the variance, Factor 3 (eigenvalue = 4.86) explains 4.76% of the variance, Factor 4 (eigenvalue = 4.01) explains 3.93% of the variance, Factor 5 (eigenvalue = 2.30) explains 2.26% of the variance and Factor 6 (eigenvalue = 1.80) explains 1.76% of the variance.

Table 5, below, shows correlational relationships between all six of the OAD (Trait)'s component scales:

Table 5: Pearson's correlations between OAD (Trait) scales (N=2,847)

	A	E	P	D	EC	CR
Assertiveness/ Autonomy	X					
Extraversion	r=.442 p=.000	X				
Patience	r=.203 p=.000	r=.313 p=.000	X			
Detail-orientation	r=.426 p=.000	r=.306 p=.000	r=.509 p=.000	X		
Emotional Control	r=.063 p=.001	r=.249 p=.000	r=.226 p=.000	r=.171 p=.000	X	
Creativity	r=.715 p=.000	r=.499 p=.000	r=.333 p=.000	r=.448 p=.000	r=.147 p=.000	X

Table 5 illustrates that all six of the OAD (Trait)'s component scales are highly interrelated (at the $p=.001$ level or above). The most notable relationship in the matrix, however, remains that between OAD (Trait)'s 'A' and 'CR' scales, which share over 50% of their variance ($r=.715$). Gray (1997) cites Cattell et al's (1970) finding that creativity and assertiveness/autonomy are conceptually linked. However, at the empirical level, the fact remains that the two constructs, at least as measured via OAD (Trait) may be so closely linked as to suggest empirical redundancy. OAD LLC plans to conduct additional studies in this area to further explore the conceptual relationship between the 'A' and 'CR' scales (see Section 7 for more on this).

4.3.3 Summary of analysis

The solution shows good evidence for the existence of five independent constructs underpinning the OAD (Trait) instrument. The following dimensions, then, exhibit independence and high item-factor loadings in line with *a priori* expectations:

- Detail-orientation;
- Extraversion;
- Patience;
- Emotional control.

While some items appeared to load on unexpected factors, 80-95% of items from these dimensions loaded as expected.

As Table 4 shows, the remaining dimensions, Assertiveness/Autonomy and Creativity load together on a single factor (Factor 1). This is not necessarily expected [despite Cattell et al's (1970) contentions] and suggests a proximal relationship between these two OAD (Trait) dimensions. On running a forced two-factor principal components analysis with the items contributing to OAD (Trait)'s 'A' and 'CR' dimensions, they were found to load separate factors, although retained a high degree of shared variance.

Overall, this suggests that while the Detail-orientation, Extraversion, Patience and Emotional control scales exhibit a high degree of empirical independence, the remaining scales are too closely correlated to be treated as *empirically* independent.

4.4 OAD and experienced stress

One of Gray's principal tenets is that the OAD scale 'Versatility', combining the Assertiveness/Autonomy, Extraversion, Patience and Detail-orientation scales, is able to indicate the extent to which an individual is able to cope under conditions of uncertainty, threat or change. A research study was carried out to investigate this proposition using a

sample of 124 UK employees (69% male) to whom OAD (Trait) and a stress indicator instrument, the ‘Pressure Management Indicator’ (PMI) (Cooper and Williams, 1996), were administered simultaneously.

The PMI was constructed by Cooper and Williams (1996) following a thorough review of an earlier iteration of the instrument, the Occupational Stress Indicator (Cooper, Sloan and Williams, 1988). The instrument contains a number of component scales relating to effects of pressure, sources of pressure, personality and coping styles. Of particular interest to the present study were the relationships between the OAD’s Versatility scale and the following PMI scales:

- **Effects: contentment** – degree of contentment/anxiety reported;
- **Effects: resilience** – extent to which the individual is able to ‘bounce back’.

Relationships between these variables appear in Table 6, below:

Table 6: Correlational relationships between OAD Versatility Level and PMI ‘Effects’ scales

	Contentment	Resilience
OAD Versatility	r=.276 p=.003	r=.286 p=.002

Table 6 shows that respondents who reported greater levels of Versatility, according to their OAD (Trait) responses, also reported higher levels of contentment (lower anxiety) and a greater degree of resilience (were more able to ‘bounce back’ when necessary). This is consistent with Gray’s original proposition that the Versatility Level scale assesses resilience under conditions of perceived stress. OAD Inc plan further research into this area to uncover relationships between the Versatility Level scale and other measures of perceived stress, as well as measures of behavioural flexibility (see Section 7 for more on this).

4.5 Summary of findings

Overall, the OAD (Trait) instrument performs fairly impressively when relationships between its component scales and those of existing personality instruments (NEO and 16-PF) are assessed. This performance is replicated to a large extent when the instrument is placed under factor analytic scrutiny. The OAD (Trait)’s Extraversion and Detail-orientation scales in particular were notable for their convergent and divergent relationships with target constructs, as well as their independence under factor analysis.

The Autonomy/Assertiveness, Patience and Creativity scales also demonstrated moderate-good construct validity when set against target constructs, with Patience reporting a high level of independence from other dimensions under factor analysis. OAD (Trait)’s Emotional Control scale reported some problems when correlated with NEO and 16-PF, although its empirical independence from other OAD (Trait) dimensions was demonstrated under factor analysis.

A close empirical relationship between the Autonomy/Assertiveness and Creativity scales was reported under factor analysis, suggesting that these two dimensions may be tapping into a similar construct, perhaps ‘independence of thinking’.

The Versatility Level ‘VL’ scale demonstrates a close relationship with Cooper and Williams’ (1996) Pressure Management Indicator’s (PMI’s) ‘contentment’ and ‘resilience’ scales, suggesting that the ‘VL’ scale may indeed tap into levels of resilience and ability to ‘bounce back’ following periods of experienced stress.

5. CRITERION VALIDITY

5.1 Introduction

Criterion-related validity pertains specifically to the relationship between an instrument's component scales/dimensions and external criteria of interest. In the case of an instrument intended for selection and development purposes, such external criteria could include work performance indicators, degree of reported satisfaction, level of commitment to the employing organisation, etc.

Criterion validation studies generally assess the degree of relationship between an instrument's component dimensions and target criteria via correlational and/or regression techniques. In this way, it is possible to identify those dimensions of an instrument which are *most predictive* of target criteria. Work by Schmidt and Hunter (1977) and by Hunter, Schmidt and Jackson (1982) established the principle of *validity generalisation*. This principle concerns the generalisation of criterion-related validity findings within a specific setting (e.g. a sales or production environment) to other, similar, settings, as long as certain critical elements are matched (e.g. job characteristics). This work is recognised by the UK research community and, more formally, by the US by the Equal Employment Opportunity Commission (EEOC), who use it as a basis for establishing the criterion-related validity of assessment and selection instruments.

A number of studies have been undertaken by OAD Inc to assess the criterion validity of OAD (Trait). Most of these are small scale and sample-specific, in that they attempt to link OAD (Trait) dimensions with company-specific performance criteria. Nonetheless, these studies provide a useful insight into the relative power of OAD (Trait) in predicting performance at work. This section contains details of three such studies. The first was conducted using a sample of 46 sales associates from a fashion retail organisation in the US. The second was undertaken with a sample of 32 retail store managers in the US and the third, with 73 management staff from a restaurant chain in Canada. Summary reports were provided to Organisational Solutions which are outlined below.

5.2 Study 1 - Fashion sales associates

Forty-six sales associates were selected as representative of the total sales population of a US fashion retail organisation. All study participants were required to complete OAD (Trait), with performance data collected from them for the first 11 months of 1994. Performance data included:

- Actual sales achieved;
- Degree to which quota exceeded;
- Hours worked per week;
- Total number of customers;
- 'Multiple count' (proportion of multiple sales made per customer);
- Sales per hour;
- Units sold per transaction.

Pearson's product moment statistic was used to assess the degree of relationship between each performance criterion and each of OAD (Trait)'s six component scales, in addition to each difference between each of the component scales (e.g. the decile difference between 'A' and 'D', for example). Statistically-significant relationships appear in Table 7, below:

Table 7: Statistically significant correlational relationships between OAD (Trait) dimensions and performance criteria for sales associates

Performance criterion	OAD (Trait) dimension/difference	Direction (sign) and degree (p) of relationship
Actual sales achieved	Emotional Control	(-) .006
Degree to which quota exceeded	Versatility	(-) .008
Hours worked per week	Emotional Control	(-) .002
Total number of customers	Emotional Control	(-) .004
'Multiple count' (proportion of multiple sales made per customer)	Emotional Control	(-) .016
Sales per hour	No relationship	NA
Units sold per transaction	Detail-orientation Versatility	(+) .012 (+) .038

These findings suggest that sales associates who are more guided by their feelings (lower EC) and are less controlled in expressing their emotions are more likely to achieve higher sales, work longer hours, and generate more (and more lucrative) customers. Sales associates who are conscientious and detail-oriented (higher D) and who appear to possess greater versatility in their trait profiles (higher VL) are more likely to sell a greater proportion of product per transaction. Finally, and perhaps surprisingly, those sales associates who possess greater versatility (higher VL) and less likely to exceed their stated sales quota.

It is perhaps surprising that the OAD (Trait)'s Extraversion dimension reported no significant relationships with the target performance criteria since this factor has been cited elsewhere as particularly predictive of sales performance (e.g. Corr and Gray, 1996). The finding that Versatility level (VL) was negatively related to meeting sales quotas was also surprising, although the study authors stress caution when interpreting this result due to anomalies in the way in which the criterion is expressed.

5.3 Study 2 – Retail store managers

Thirty-two retail store managers from the automotive parts industry participated in the second study, which saw their six-monthly performance during the first half of 1994 correlated with results from OAD (Trait). Performance data collected were as follows:

- **Quota** – percentile score against established sales volume quota;
- **Phone/store service** – 'mystery shopper' index, obtained by visiting/phoning each store and requesting information regarding particular products;
- **Retail green sheet** – internal store evaluation undertaken by District Manager;
- **Manager's Personal Performance Index (PPI)** – composite score comprising all performance indicators.

Pearson's product moment statistic was used to assess the degree of relationship between each performance criterion and each of OAD (Trait)'s six component scales, in addition to each difference between each of the component scales (e.g. the decile difference between 'A' and 'D', for example). Statistically-significant relationships appear in Table 8, below:

Table 8: Statistically significant correlational relationships between OAD (Trait) dimensions and performance criteria for retail store managers

Performance criterion	OAD (Trait) dimension/difference	Direction (sign) and degree (p) of relationship
Quota	Detail-orientation	(+) .04
Phone/store service	No relationship	NA
Retail green sheet	Detail-orientation-Extraversion Detail-orientation-Patience	(+) .02 (+) .04
Manager's PPI	No relationship	NA

Table 8 suggests that the OAD (Trait)'s 'Detail orientation' dimension ('D') may be a critical predictor of performance for retail store managers. Those managers with 'D' ratings significantly higher than ratings of Extraversion and Patience achieved better internal reviews from District managers. Those managers with high 'D' ratings also achieved higher quota ratings.

5.4 Study 3 – Restaurant management staff

Seventy-three managers and assistant managers from a Canadian restaurant chain participated in the third study which involved concurrently administering OAD (Trait) and collecting performance data from the organisation in the following areas:

- **Tenure** – length of employ with the organisation;
- **Composite performance** – aggregated using an ordinal rating scale ranging from 'A' (exceeds standards) to 'X' (failing), across 14 separate performance indicators.

Pearson's product moment statistic was used to assess the degree of relationship between each performance criterion and each of OAD (Trait)'s six component scales, in addition to each difference between each of the component scales (e.g. the decile difference between 'A' and 'D', for example). Statistically-significant relationships appear in Table 9, below:

Table 9: Statistically significant correlational relationships between OAD (Trait) dimensions and performance criteria for restaurant management

Performance criterion	OAD (Trait) dimension/difference	Direction (sign) and degree (p) of relationship
Composite performance	Extraversion-Patience	(+) .0001
	Extraversion-Detail-orientation	(+) .0001
Tenure	Autonomy/Assertiveness	(-) .04
	Extraversion	(-) .02
	Emotional Control	(+) .004

As regards composite performance in the job, Table 9 suggests that OAD (Trait)'s Extraversion dimension may be a critical predictor. Those management staff who reported a high Extraversion rating compared with Patience and Detail-orientation ratings also achieved higher overall performance ratings.

Interestingly, study findings also showed that performance was significantly *negatively* related to organisational tenure ($p=.04$). Thus, the finding that long-serving staff reported lower ratings of Extraversion was unsurprising.

5.5 Summary

Criterion-related validation is crucial to ensure that an instrument used for selection and/or development is statistically related to the 'real-world' criteria it sets out to predict. Schmidt and Hunter's (1977) pioneering work in validity generalisation make it possible to generalise predictive findings obtained within a specific occupational setting to a wider population, as long as key job characteristics are equivalent.

The example studies summarised in this Section provide an indication of the potential of OAD (Trait) in predicting performance within various occupational and organisational environments. Clearly, users of OAD (Trait) benefit most greatly from the instrument by undertaking their own 'local' validation study in order to link performance directly to OAD (Trait) findings within their own organisation. OAD LLC provides this service as part of the annual licensing package.

6. TEST BIAS

6.1 Introduction

When constructing a psychometric instrument, especially one designed for use in a selection setting, it is critical to ensure that specific groups completing the instrument are not unfairly disadvantaged due to inherent biases in that instrument. Biases can derive from the following sources (Rust and Golombok, 1999):

- **Item bias** – individual items are biased towards specific groups (e.g. US language used for UK instrument);
- **Intrinsic test bias** – the test is constructed and standardised using a group unrepresentative of the population for whom it is ultimately intended;
- **Extrinsic test bias** – the test discriminates against a specific group due to factors outside the scope of the test itself but leading to significantly different results for that group when compared with the population against which the test has been standardised.

6.2 Item bias

The OAD instrument was originally developed in the US over the period 1987-1990. Prior to its release in the UK in 1995, the items comprising the test were reviewed for comprehensibility by a UK population. It was determined that several items would require ‘anglicisation’ prior to release of the instrument in the UK. The original items and their anglicised versions appear in Table 10, below:

Table 10: The Anglicisation of OAD (Trait)

Original US item	Anglicised version
Suggestible	Gullible
Confrontive	Confrontational
Egotistical	Self-centred
Distractible	Easily distracted

Item distributions were analysed across US and pilot UK samples to ensure that item meanings were comparable. Once this was complete, a UK version of the instrument was released in 1995.

6.3 Intrinsic test bias

The OAD (Trait) software utilises a US dataset (N=approx. 2,000) in order to produce standard scores (based on a decile distribution) for both UK and US candidates. In order for this to be acceptable, the scale properties for US and UK datasets must be equivalent. If this is not the case, it may be that intrinsic test bias is present, in that individuals from a national group may be significantly advantaged or disadvantaged due to the use of a non-comparable norm group for standardisation purposes.

Table 7, below, presents scale means and standard deviations for the US and UK datasets for the OAD (Trait) instrument. The UK dataset properties are calculated from the 2,842-strong sample used throughout this report. The US scale properties derive from a sample of 234, drawn from the overall US dataset which is used to calculate decile values. Results of significance tests also appear in Table 11.

Table 11: Comparison of US and UK dataset properties for OAD (Trait)

Scale	Mean (UK)	Mean (US)	Standard deviation (UK)	Standard deviation (US)	t-test significance
A	7.9	8.0	4.1	4.2	n.s.
E	8.4	8.5	3.4	3.7	n.s.
P	4.9	5.2	2.7	3.2	n.s.
D	10.8	10.9	4.4	4.7	n.s.
V	31.8	32.7	10.7	9.5	n.s.
EC	3.1	4.5	2.2	2.3	p=.01
CR	7.9	7.2	3.9	4.1	n.s.

Table 11 shows that scale properties are equivalent for all OAD (Trait) scales excepting OAD ‘Emotional Control’. The US sample shows a significantly higher degree of Emotional Control than the UK sample. This suggests that for the ‘EC’ scale, some bias may exist, which may have led to UK delegates being unfairly disadvantaged when compared against the US standardisation dataset (on the assumption that emotional control is a ‘desirable’ attribute). As a result, since the OAD’s 1995 launch in the UK, the OAD standardisation software has used separate norm data for the calculation of standardised EC scores for the UK population. This source of bias is, therefore, accounted for in the standardisation software.

As regards gender differences, the US dataset against which candidate scores are standardised contains an approximately 1:1 ratio of males: females. This should minimise any potential gender-specific intrinsic test bias.

6.4 Extrinsic test bias

Relatively little research has been undertaken with OAD (Trait) examining potential adverse impact with ethnic groups. Data pertaining to ethnic origin are not routinely collected via OAD (Trait) and so any judgement relating to adverse impact on this basis cannot be made. Gender data, however, are collected via OAD (Trait), and gender differences across the instrument’s 6 scales may be assessed. Table 12, below, shows mean differences by gender for each OAD (Trait) scale along with results of significance tests comparing the mean values. The sample includes 1,816 UK males and 787 UK females.

Table 12: Comparison of male and female mean scores on OAD (Trait)

Scale	Mean (Male)	Mean (Female)	Standard deviation (Male)	Standard deviation (Female)	t-test significance
A	8.6	6.2	3.9	4.0	p=.001
E	8.3	8.6	3.3	3.6	p=.008
P	5.1	4.3	2.8	2.5	p=.001
D	11.2	9.7	4.3	4.3	p=.001
V	33.2	28.8	10.4	10.7	p=.001
EC	2.9	3.6	2.1	2.4	p=.001
CR	8.6	6.4	3.8	3.8	p=.001

Table 12 shows that significant differences exist between the sexes on all six of the OAD (Trait) scales. This is similar to findings with many personality questionnaires (e.g. NEO, 16-PF, MMPI, CPI, EPQ, etc.). However, the majority of these questionnaires provide separate norm data for male and female groups. OAD (Trait) standardises candidate scores based on mixed-sex sample of around 2,000 adult employees. According to Table 8, females are likely to score significantly lower than males on the 'A', 'P', 'D', 'V' and 'CR' scales and significantly higher than males on the 'E' and 'EC' scales.

It should be noted that the sample contained in Table 10, above, comprises a mixed occupational sample which may under-represent females in executive and managerial positions and over-represent females in clerical positions. This may affect mean estimates for males and females resulting in biased group comparisons. To account for this potential bias, two sets of independent samples t-tests were run with specific occupational groups: production staff (the sample containing 220 males and 170 females), and middle managers (the sample containing 474 males and 104 females). Results appear in Tables 13-14, below:

Table 13: Comparison of male (N=220) and female (N=170) production staffs' mean scores on OAD (Trait)

Scale	Mean (Male)	Mean (Female)	Standard deviation (Male)	Standard deviation (Female)	t-test significance
A	6.0	3.9	3.5	3.2	p=.001
E	8.2	8.0	3.1	3.1	n.s.
P	5.5	4.4	2.8	2.3	p=.001
D	10.2	8.6	4.8	4.1	p=.001
V	29.9	25.0	11.4	10.0	p=.001
EC	2.8	3.0	2.1	2.0	n.s.
CR	6.0	4.1	3.6	2.8	p=.001

Table 14: Comparison of male (N=474) and female (N=104) middle managers' mean scores on OAD (Trait)

Scale	Mean (Male)	Mean (Female)	Standard deviation (Male)	Standard deviation (Female)	t-test significance
A	9.6	8.3	3.7	3.6	p=.001
E	8.3	8.5	3.2	3.6	n.s.
P	5.1	4.1	2.8	2.7	p=.001
D	12.0	10.6	4.0	4.1	p=.001
V	35.0	31.5	9.8	9.4	p=.001
EC	2.7	3.3	1.9	2.2	p=.002
CR	9.4	8.0	3.7	3.8	p=.001

As can be seen from Tables 13 and 14, even when gender differences are controlled for occupation, significant differences do exist between the groups. This is true of all OAD (Trait) scales excepting Extraversion (for both occupational samples) and Emotional Control (for the production sample).

This may well reveal 'real' gender differences in the underlying traits assessed by OAD (Trait). However, it leaves the instrument open to potential criticism on the grounds of adverse impact and it is recommended that gender-specific norms are made available for comparison when requested by a client. *(Note: gender differences scores were corrected in 2001 by recalculation of standardised scores and recoding several items).*

6.5 Summary

During development and validation of the OAD (Trait), several measures have been implemented to ensure that the instrument contains no inherent biases which would prejudice particular groups. In order that OAD (Trait) retained maximum item comprehensibility when 'translated' to the UK market, four items were reworded using equivalent terminology. During standardisation of OAD (Trait), a gender-mixed sample was used which minimised intrinsic gender-specific bias. Differences found between US and UK populations as regards 'EC' scores led to the development of a software 'patch' which compares UK candidates to the UK population for this dimension.

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UK Sample (n = 2842) – Gender and Job Distribution

Gender:	N:	Percent:
Male	1,816	63.9
Female	787	27.7
Unknown	239	8.4
Total	2,842	100.0
JOB	Frequency:	Percent:
Executive	214	7.5
Sales	289	10.2
Middle Management	617	21.7
Technical	339	11.9
Supervisory	123	4.3
Clerical	230	8.1
Production	425	15.0
Unknown	571	20.1
Police & Military	5	0.2
Teachers	29	1.0
Total	2,842	100.0

Representative Sampling: .93 (Olken)