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P-TECHNIQUE FACTOR ANALYSIS AND THE CONSTRUCT VALIDITY OF EMOTIONAL STATE SCALES

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ABSTRACT

The objectives of this study were two-fold (a) to investigate the factor structure of the Central State Trait Kit (CST) (Barton 1978) and hence evaluate its construct validity and (b) to develop criteria which can be applied in cases where overall "simple structure" is not high, to allow the optimum identification of the psychological 'meaning' of factors.

Specifically, P-technique factor analysis was performed on 200 repeated measures over all state items. Results provided both evidence for the construct validity of the CST and demonstrated useful alternative criteria to "simple structure" in the understanding of the meaning of factors.

INTRODUCTION

The theory behind the measurement of psychological *states* and concrete examples of such measurement has been recently the topic of much debate and has been outlined elsewhere (e.g., Barton, in press). What is of interest in this current study is the construct validity of a specific instrument that purports to measure psychological states (The Central State-Trait Kit [CST] Barton, 1978). There are several studies that devote themselves to analysis of concrete or criterion validity of emotional state measures (e.g., Barton & Cattell, 1974; Barton, 1978), but few, if any, that concern themselves with construct validity. It is hoped, however, that this present study does more than fill a gap in the knowledge of the psychometric properties of emotional states. A secondary, but important, objective here is to demonstrate the use of p-technique factor analysis as a useful tool in the investigation of *changes* in psychological states over time. Cattell (1984) and others have repeatedly extolled the virtues of p-technique and chain p-technique but relatively few converts are evident. Indeed, a recent computer search of research literature (1983) dealing with both p-technique and psychological states, resulted in only six "finds" (two of which were authored or co-authored by the present writer). A brief synopsis of these half-dozen studies follows.

In 1982, Tobacyk reported on a p-technique factor analysis in which 31 undergraduate students rated their moods three times a day for 33 consecutive days. Sixteen scales were involved, and separate 16 x 16 matrices were calculated and factored for each person. Results provided information regarding the affective complexity of each person in the study. A 1976 study by Bath, Daly and Nesselroade used p-technique factor analysis to examine the replicability of state dimensions *across* people. To do this, Bath et al. asked four hospitalized female schizophrenics to estimate how they rated themselves on 25 behavior categories. Each patient made ratings three times a day for 60 days. Correlation matrices (25 x 25) were obtained for each patient, factor analyzed by p-technique and the resulting factor structures then compared across patients. Results showed that three factors were consistently exhibited by all four patients: Anxiety, Extraversion, and Social Desirability. Barton, Cattell and Conner (1974) reported data on one person who was tested for 99 days on 68 physiological and psychological measures. The variables were correlated over occasions and the resulting p-technique factor analysis indicated that eight of the resulting factors, matched dimensions that had been shown to be important in previous studies by independent researchers. Daly, Bath and Nesselroade (1974) compared the use of p-technique in the investigation of inter- and intra-individual differences. To do this, Daley et al. contrasted the results obtained when p-technique was performed separately on several people, to that obtained when results were pooled across people (i.e., chain p-technique). The three common moods derived from the p-technique analyses were not confirmed by the chain p-technique and the authors caution researchers against the use of chain p-technique whenever the more conventional p-technique is available. Barton, Cattell and Conner (1973) factor analyzed the Seven State Questionnaire (SSQ) with the major objective of defining "fatigue" and "arousal" as either ends of a bi-polar factor or as separate factors. A second intent of this study was to compare dR factor analysis with that of p-technique. Results showed "fatigue" and "arousal" to be separate factors (and hence called for an "Eight-State Questionnaire") and also demonstrated the complementary use of p and dR techniques. Steward and Steward (1976) confirmed the structure of the Eight-State Questionnaire mentioned above, by obtaining scores from a person over a 30-day period. Twice a day (morning and evening) the subject reported her mood states as reflected by the Eight-State Questionnaire. Measures were correlated over the 60 occasions of measurement and the resulting correlation matrix subjected to a p-technique factor analysis. Results readily supported the factorial validity of the 8 SQ and once again p-technique proved to be a powerful tool in the demonstration of the structure of statelike factors.

In summary then, the relatively few studies that have explored the use of p-technique as a method for estimating the construct validity of state factors, have shown that this type of factor analysis can be a useful and powerful tool. This present study uses p-technique to examine the factor structure and hence the construct validity, of the Central Trait-State (CTS) kit.

P-TECHNIQUE FACTOR ANALYSIS

METHOD

SUBJECTS

The two people involved in the study were a married couple in their early 30's. The woman was a graduate student in the social sciences and the man was a professor in the physical sciences (University of California campus). At the time of data collection neither subject was aware of the kinds of analyses that would be subsequently carried out. They were told that the study would involve looking at how moods change over time. A major problem in obtaining p-technique data is that the subjects must be highly motivated to complete the study since the design inherently involves repeated testing over a long time period. In the case of the couple in the present study, the motivation was high since the woman intended to use the data in her Master's thesis and the husband wanted his wife to finish too.

TESTS

The state scales from form A of the CTS kit were used as measures of mood. These scales consisted of 25 items each and measure the five second-order state factors: anxiety, extraversion, independence, cortertia and conscientiousness. Each scale consists of items in statement form to which responses may be made in one of the following categories: (1) strongly agree; (2) agree; (3) slightly agree; (4) slightly disagree; (5) disagree; (6) strongly disagree. The directions pointed at the top of each subtest reads as follows: "Please read each item carefully. Then place a check (✓) under the column which best reflects HOW YOU ARE FEELING RIGHT NOW, IN YOUR PRESENT MOOD."

PROCEDURE

Each subject was asked to complete the five scales twice a day with a minimum of two hours between the testing times. In actual fact, for most days the interval between test times was much greater than two hours. It was expected that with time the tests would be completed faster and faster but in fact the opposite occurred since the subjects reported increasing "resistance" to completing the questionnaire. However, both subjects did provide 50 days of data or 100 observations each. Each item was correlated with every other item resulting in a 125 x 125 correlation matrix. The items were correlated over both subjects and occasions, thus providing a matrix suitable for a chain p-technique factor analysis. Communalities were calculated and replaced the unities in the diagonal of the original correlation matrix. The eigen values associated with each variable were calculated and plotted graphically. A Scree Test (Cattell, 1958) on this plot indicated the extraction of seven factors. An oblique factor analysis was performed and details from the resulting rotated factor structure matrix are shown in Table 1.

Table 1

FACTOR STRUCTURE LOADINGS OF THE CTS KIT ITEMS

Item #	Inde-pendence (Factor 2)	*	Anxiety (Factor 3)	*	Extra-version (Factor 5)	*	Conscien-tiousness (Factor 6)	*	Cortertia (Factor 7)	*
1	+.33	+	-.24	-	-.50	-	-.11	-	+.46	+
2	-.21	-	-.37	-	-.58	-	-.22	-	+.45	+
3	-.13	-	+.40	+	-.45	-	-.10	-	+.29	-
4	-.61	-	+.34	+	-.53	-	+.41	+	-.60	-
5	+.12	+	+.34	+	+.49	+	+.03	+	-.34	+
6	-.16	-	+.36	+	+.61	+	-.22	-	+.44	+
7	+.24	+	-.26	-	-.40	-	+.65	+	+.09	-
8	-.15	-	-.18	-	+.38	+	-.45	-	+.69	+
9	+.23	+	+.26	+	-.33	-	-.18	-	-.30	-
10	-.53	-	+.19	+	-.24	+	+.42	+	-.47	+
11	+.14	+	-.31	-	-.61	-	-.10	-	+.10	+
12	-.30	-	+.28	+	-.52	-	+.54	+	-.33	-
13	+.32	+	+.44	+	+.48	+	+.16	+	-.47	+
14	+.20	+	+.64	+	-.33	-	-.33	-	+.50	+
15	-.37	-	+.26	+	-.31	-	+.36	+	-.58	-
16	-.24	-	+.23	+	+.20	+	-.30	-	+.47	+
17	-.19	-	-.42	-	-.51	-	-.24	-	-.34	-
18	+.35	+	-.21	-	+.49	+	+.74	+	+.17	+
19	+.04	+	+.27	+	-.19	-	+.40	+	+.24	+
20	-.45	-	+.47	+	-.48	-	+.38	+	+.32	+

The specific choice of an oblique solution involved the BMD package program Oblimin [BMD P4M]. Gamma was set equal to zero and communalities of the variables were defined and calculated as squared multiple correlations with the factors. As can be seen from Table 2 this oblique solution resulted in factors that were for the most part independent of each other, the highest correlation being 0.32 (between independence and extraversion).

Table 2

FACTOR INTERCORRELATIONS
(ROTATED OBLIQUE FACTORS)

	1	2	3	4	5
1.	1.00				
2.	-.13	1.00			
3.	.32	-.25	1.00		
4.	.25	-.32	.27	1.00	
5.	.01	-.07	.10	.08	1.00

1 = Independence
2 = Anxiety
3 = Extraversion
4 = Conscientiousness
5 = Cortertia

RESULTS AND CONCLUSIONS

The total factor structure is, of course, much larger than the matrix shown in Table 1. The reduction in size is obtained by only reporting the factor loadings of the "marker" items for each factor, i.e., the items numbers in the first column of Table 1 refer to different sets of items for each of the factors. While this has the advantages of clarity, decreased printing costs and small space requirements, the reader is left without any information as to how items loaded on factors other than the one they defined, i.e., "marked." Indeed, many items not only loaded other factors in addition to the one they were purported to "mark" but even had higher loadings on some of these factors, i.e., the factor structure matrix had been rotated to maximize "simple structure" but the maximum achieved was not high.

In the light of this problem, two criteria were defined in order to provide guidance in selecting which factor best represented a total set of putative items. For example, the first 25 items in the factor structure matrix were "supposed" to measure anxiety. The problem was which of the seven factors extracted best represent these items.

The first criterion involved the *pattern* of item scores. For each set of putative items, roughly half the items are scored in a positive direction (i.e., "strongly agree" indicates a high scores) and the rest in a negative direction. It was argued that if this scoring key *pattern* for the items was reflected in the signs of the loadings of a factor, then (other things being equal) this factor could be considered the one best defining the items.

The second criteria for factor identification focused on the absolute magnitude of the factor loadings. It was argued that if more than one factor satisfied the first criterion, i.e., matched the pattern of item scores on signs, then the average absolute magnitude of the factor loadings (across all putative items) should be

calculated. The factor that showed the highest average loading could be considered as most representative of the set of items as a whole.

These criteria were applied to the total factor structure matrix and led to the identification of five factors as shown in the first row of Table 1 (e.g., factor 2 as Independence, etc.). The degree to which each identification was supported is indicated by the data on criteria matching as shown in Table 3.

Table 3

FACTOR IDENTIFICATION AS A FUNCTION OF CRITERIA MATCHING

Factor Identification	1. Degree of Match	2. Average Magnitude of Loading
Independence as Factor 2	100% Match	.27
Anxiety as Factor 3	100% Match	.32
Extraversion as Factor 5	100% Match	.43
Conscientiousness as Factor 6	100% Match	.32
Cortertia as Factor 7	75% Match	.38

As can be seen in Table 3 with the exception of factor seven, 100% match was observed for the punitive sets of item signs and the actual factor loadings. The average magnitude of the factor loadings was reasonable for all scales, especially when one notes that these averages hold over 20 items per scale.

In summary then, it is concluded that the data in Tables 1, 2 and 3 demonstrate reasonable construct validity for the CTS scales and illustrate the usefulness of p-technique factor analysis as a tool for shedding light on the structure of emotional state scales. It is planned to gather further data on the CTS, this time across many people, and the resulting factor analysis will be contrasted with the present "within-people" structure.

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