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Individual Differences in Anxiety Responses to Stressful Situations: A Three-Mode Component Analysis Model

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Abstract

The three-mode component analysis model is discussed as a tool for a contextualized study of personality. When applied to person × situation × response data, the model includes sets of latent dimensions for persons, situations, and responses as well as a so-called core array, which may be considered a summary description of the individual differences in response profiles across situations. Underlying psychological processes may be further revealed by relating the model to external data on cognitive–affective personality system (CAPS) variables. The model as well as its validation in CAPS terms is illustrated with self-report data on anxiety responses displayed by several persons in a sample of situations. Furthermore, the model is tested against recently formulated criticisms regarding the use of (two-mode) factor analysis in personality research, and its relation to the triple typology model recently proposed by Vansteelandt and Van Mechelen (1998) is briefly discussed. Copyright © 1999 John Wiley & Sons, Ltd.

INTRODUCTION

A number of standard approaches to personality describe and explain individual differences in personality functioning without referring to specific situations or specific responses. Prominent examples include various trait models such as the Big Five model (Digman, 1990; McCrae and Costa, 1987; Goldberg, 1990, 1993; John, 1990), in which individual differences in personality functioning are captured in terms of broad, abstract labels such as introversion–extraversion, neuroticism–emotional stability, friendliness–unfriendliness, etc.

On an empirical level, the fact that trait theories typically leave references to specific situations and specific responses beyond consideration often shows up in research

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with questionnaires, the items of which either do not include any reference to situations or responses (such as trait adjectives, personality-descriptive verbs, or trait nouns as studied in lexical approaches to personality, see e.g. De Raad, Mulder, Kloosterman and Hofstee, 1988; De Raad and Hoskens, 1990; John, Angleitner and Ostendorf, 1988) or which include such references in an unsystematic way (some items including no references, others a reference to a specific situation, to a specific response, or to both). On a theoretical level, at least three reasons may be distinguished for not including references to specific situations and responses in accounts of individual differences in personality functioning. (1) One may assume that individual differences in behaviour are stable across different situational contexts or across different instances of trait-relevant behaviour. (2) One may prefer to study and model differences in overall act trends (Buss and Craik, 1983), that is, behaviour summaries averaged across various occasions, contexts, as well as trait-relevant behaviours; one possible reason for doing so is that averaging may be considered an effective if not the only possible way to capture stable, reliable individual differences (Epstein, 1986). (3) One may prefer not to include explicit references to specific situations or specific behaviours because such references are already implicitly present: 'being characterized by a trait automatically implies the relevant type of situation' (Johnson, 1997, p. 75); for instance, if somebody scores high on a trait such as extraversion, one may argue that this does not mean that this person will display extraverted behaviour in all kinds of context, but rather that (s)he will display extraverted behaviour in trait-relevant contexts (e.g. social situations); the latter means that many trait constructs such as extraversion–introversion are, at least on an implicit level, conditional constructs, that entail well defined if [situation] then [behaviour] rules (Wright and Mischel, 1987).

Yet, objections may be raised against each of the three arguments stated above. (1) Regarding the consistency issue, ample research evidence has documented that in the personality domain the stability of individual differences in behaviour, both across different situations and across different trait utterances, is typically very low (albeit nonzero) (see e.g. Kenrick and Funder, 1988; Mischel, 1968; Mischel and Shoda, 1995). (2) Regarding act trends, however useful they may be in some cases, one can argue that they only give a picture of somebody's average behaviour, in which much behavioural richness is lost. To an exclusive attention for averages one may apply Galton's caricature of an English tourist 'whose retrospect of Switzerland was that, if its mountains could be thrown into its lakes, two nuisances would be got rid of at once' (Galton, 1889). (3) Regarding the argument that many trait constructs implicitly are conditional dispositional constructs, one may reply that, in general, the relation between traits and situations may be complex; moreover, it often can be useful to make explicit the conditional rules behind traits, amongst other things in order to refine them (e.g. many possible conditions other than 'trait-relevant contexts' could be considered) and in order to make them amenable to empirical research (see e.g. Van Heck, Perugini, Caprara and Fröger, 1994).

One may therefore wish to go beyond decontextualized approaches to personality and move to studies of individual differences that include explicit references to specific contexts and specific behaviours. In particular, one may wish to study individual differences in terms of well defined behavioural profiles across situations. Those can be considered *behavioural signatures* of people's personality systems (Mischel and Shoda, 1995, 1998). It is interesting to note that for such behavioural signatures or

profiles fairly high stabilities across occasions have been reported (Mischel and Shoda, 1995).

The overall goal of contextualized approaches to personality is twofold and may be summarized as follows: (1) the search for overall parsimonious descriptions of individual differences in behavioural profiles across situations and (2) an account of those individual differences in terms of underlying structural and process-related variables. The first goal implies the search for relevant active psychological situational features that are important in discriminating between behavioural contexts. With respect to the second goal, Mischel and Shoda (1995, 1998) sketched the outline of a comprehensive framework in their theory of the so-called *cognitive–affective personality system* (CAPS). The latter system is supposed to consist of different cognitive-active units, including encodings, affects, goals, and self-regulatory plans, which are assumed to play a mediating role between active situational features and specific behaviours. Individual differences are assumed to exist in the availability/accessibility of these units, as well as in their mutual links and their links with situational features and behaviours. For example, a certain individual may display a predictable pattern of flight responses in novel, ambiguous situations, because he is strongly inclined to encode such situations as potentially physically threatening (i.e. by a high accessibility of a physical threat encoding unit). The physical threat encoding unit, in its turn, may activate a defensive self-regulatory plan which may ultimately result into a flight reaction.

Stating the goals of contextualized approaches of personality is rather simple. Realizing them, however, is quite a different story, in particular because it implies a disentangling of an extremely complex whole of situational and behavioural aspects as well as potentially relevant mediating mechanisms. Because of this complexity one may run the risk that pleas for contextualized approaches could end up as nothing but loose, wishful declarations of intent.

A way out for the latter problem may be looked for by making an appeal to formal models. This is the route we will take in the present paper. In doing so, we will primarily (but not exclusively) focus on the first goal of contextualized approaches to personality, the search for parsimonious descriptive summaries of individual differences in situation–behaviour profiles.

To meet the first goal of contextualized approaches to personality, observations or self-report data on specific behaviours of several individuals in various contexts are needed. As an important special case, one may consider that data on behavioural presence or intensity are available for all combinations of a person, a situation, and a behaviour out of given sets of persons, situations, and responses. This type of data is called three-mode three-way data (Carroll and Arabie, 1980) because three different sets of entities (*modes*) are involved (persons, situations, and responses), and because the data can be written in an array with three dimensions (*ways*). A standard way to obtain three-mode three-way data is by administering a stimulus–response questionnaire to a group of subjects.

For the representation of three-mode three-way person × situation × response occurrence/nonoccurrence data (i.e. yes/no data from a set of persons on the occurrence of each response out of a set of responses in each situation out of a set of situations) Vansteelandt and Van Mechelen (1998) proposed a so-called triple typology model. In line with a call from Bem (1983), the latter model includes three (hierarchically organized) typologies of persons, situations, and responses. The three

typologies are further linked: persons of the same person type share distinctive behavioural profiles across situations which can be characterized in terms of particular sets of *if* (situation type) *then* (behaviour type) rules, in line with the framework of Mischel and Shoda (1995, 1998). The triple typology model is an instance of the INDCLAS model as developed by Leenen, Van Mechelen, De Boeck and Rosenberg (1999); the latter goes with an algorithm that allows the user to induce a triple typology model from empirical data. The psychological mechanisms underlying the resulting model may further be revealed by relating the person typology to external data on cognitive–affective personality system (CAPS) variables. This was illustrated by Vansteelandt and Van Mechelen in a study of self-reported hostile behaviour in frustrating situations. Their analysis revealed both quantitative and qualitative individual differences in hostile behaviour, some of which could be accounted for in terms of individual differences in hostile encoding (i.e. the tendency to interpret aversive experiences as purposefully aggressive) and the expectancy that overt expressions of anger would lead to negative reactions from others, the latter two being CAPS-related variables.

As indicated above, the triple typology model is intended to represent *binary* person × situation × behaviour data. For the representation of *continuous* person × situation × behaviour data (i.e. data on the *degree* or *extremity* of each of the responses), alternative models are needed. In this paper, one such model, the three-mode component analysis (3MCA) model, will be presented. In the next section this model will be outlined and its significance for a contextualized study of personality will be clarified with a simple hypothetical example. The model description is followed by a section in which an illustrative application of the model is presented as applied to real data obtained with one of the most archetypal S–R questionnaires, the S–R Inventory of Anxiousness (Endler, Hunt and Rosenstein, 1962). The article ends with a section containing some concluding remarks.

THE 3MCA MODEL

Given a set of continuous three-mode three-way data, say person × situation × response data, three-mode component analysis searches for three limited sets of (unobserved) variables defined on the persons, situations, and responses, respectively. The variables of the three sets are called person, situation, and response components. The component variables may be considered as underlying person, situation, and response dimensions. From the component variables one may approximately reconstruct the original data (approximation to be understood in a least squares sense). In the reconstruction, a small three-way array, called the *core*, is used; the latter indicates to what extent certain persons that score high on some person dimension will display certain responses that score high on some response dimension in situations that score high on some situation dimension. Or, stated in an alternative way, the core will display a summary description on the level of the unobserved component variables of the structure of the individual differences in behavioural profiles across types of situation.

More specifically, given an $I \times J \times K$ person × situation × response data array $\mathbf{X}$ with X_{ijk} denoting the score of person i on response k in situation j, 3MCA searches for P (unobserved) variables defined on the persons, Q (unobserved) variables defined

on the situations, and R (unobserved) variables defined on the responses, called person, situation, and response components, respectively. Note that the numbers of the three kinds of component, P, Q, and R, may differ from each other. The three sets of components are associated with matrices **A**, **B**, **C**, with entries a_{ip} denoting the score of person i on person component p, b_{jq} the score of situation j on situation component q, and c_{kr} the score of response k on response component r. From the three sets of components the data may be approximately reconstructed through the rule:

$$x_{ijk} \cong \sum_{p=1}^{P} \sum_{q=1}^{Q} \sum_{r=1}^{R} a_{ip} b_{jq} c_{kr} g_{pqr} \tag{1}$$

with **G** denoting the core array, the entries g_{pqr} of which indicate to what extent persons that score high on person component p will display responses that score high on response component r in situations that score high on situation component q.

To clarify the model outlined above, we use a hypothetical data set of six persons for whom five anxiety responses have been recorded in four stressful situations (see Table 1). The data were chosen such that they can be represented exactly by a 3MCA model with $P = 3$ and $Q = R = 2$. The corresponding component matrices **A**, **B**, and **C** and the core array **G** are given in Table 2. One may check that the data as shown in Table 1 can be obtained indeed from the 3MCA model of Table 2, making use of formula (1). For example, with respect to the thought blocking behaviour ($k = 2$) of John ($i = 1$) in the situation with a dangerous dog ($j = 3$), it holds that:

$$\begin{aligned} x_{132} &= \sum_{p=1}^{P} \sum_{q=1}^{Q} \sum_{r=1}^{R} a_{1p} b_{3q} c_{2r} g_{pqr} \\ &= a_{11} b_{31} c_{21} g_{111} + a_{11} b_{31} c_{22} g_{112} + a_{11} b_{32} c_{21} g_{121} + \cdots \\ &= 2 \times 0 \times 1 \times 0 + 2 \times 0 \times 0 \times 0 + 2 \times 3 \times 1 \times 3 + \cdots \\ &= 0 + 0 + 18 + \cdots \\ &= 18. \end{aligned} \tag{2}$$

From Table 2 we may derive that 'job interview' and 'public speech' score high on the first situation component, which is therefore labelled 'public performance'. The two other situations, 'bumping into a dangerous dog' and 'sailing on a rough sea' score high on the second situation component, which we therefore label 'Physical threat'. Similarly, the response components can be interpreted as 'Freezing' (given the high scores of the two blocking responses) and 'Physiologic' (given the high scores of sweating and trembling, and, to a somewhat lesser extent, stomach contractions). The lowermost part of Table 2 contains the core of the model, which indicates to what extent persons who score high on each of the three person dimensions of the model display responses that score high on each of the two response components in situations that score high on each of the two situation components. For example, persons scoring high on the first person component will display all kinds of anxiety response in situations scoring high on a physical threat dimension. Interestingly, the core array, as illustrated in Table 2, may reveal several types of intra- as well as inter-individual

Table 1. Hypothetical data on five anxiety responses from six persons recorded in four stressful situations

	Job interview					Public speech					Dangerous dog					Sailing on rough sea				
	R_1	R_2	R_3	R_4	R_5	R_1	R_2	R_3	R_4	R_5	R_1	R_2	R_3	R_4	R_5	R_1	R_2	R_3	R_4	R_5
John	0	0	0	0	0	0	0	0	0	0	36	18	12	24	6	24	12	8	16	4
Mary	0	0	4	8	2	0	0	3	6	1.5	0	0	0	0	0	0	0	0	0	0
Bill	0	0	4	8	2	0	0	3	6	1.5	18	9	18	36	9	12	6	12	24	6
Bob	0	0	6	12	3	0	0	4.5	9	2.3	0	0	6	12	3	0	0	4	8	2
Sarah	0	0	10	20	5	0	0	7.5	15	3.8	0	0	6	12	3	0	0	4	8	2
Ann	0	0	8	16	4	0	0	6	12	3	18	9	18	36	9	12	6	12	24	6

Note: R_1 = movement blocking, R_2 = thought blocking, R_3 = tremble, R_4 = sweat, R_5 = stomach contraction.

Table 2. Person, situation, and response scores as well as core array of 3MCA model for data of Table 1

A: Person component scores

Persons	P-component 1	P-component 2	P-component 3
John	2	0	0
Mary	0	0	1
Bill	1	2	0
Bob	0	1	1
Sarah	0	1	2
Ann	1	2	1

B: Situation component scores

Situations	S-component 1 (public perform.)	S-component 2 (physical threat)
Job interview	2	0
Public speech	1.5	0
Dangerous dog	0	3
Sail. rough sea	0	2

C: Response component scores

Responses	R-component 1 (freeze)	R-component 2 (physiologic)
Movement block.	2	0
Thought blocking	1	0
Tremble	0	1
Sweat	0	2
Stomach contr.	0	0.5

G: Core

	S-component 1 (public perform.)		S-component 2 (physical threat)	
	R-component 1 (freeze)	R-component 2 (physiologic)	R-component 1 (freeze)	R-component 2 (physiologic)
P-component 1	0	0	3	2
P-component 2	0	1	0	2
P-component 3	0	2	0	0

differences. As such, persons scoring high on the first person component primarily differentiate between public performance and physical threat situations, anxiety responses being displayed by them only in the latter type of situations. On the other hand, persons scoring high on the second person component are characterized by a distinct response stereotypy in that they primarily differentiate between freezing and physiologic anxiety responses and display only the latter type of response in all types

of stressful situation. Finally, persons scoring high on the third person component differentiate both between situations and responses.

As such, the 3MCA model as outlined in Table 2 may be considered a summary description of the structure of the individual differences in anxiety behaviour profiles across stressful situations. One may wish to go beyond such a structural description in order to reveal underlying process-related mechanisms. In order to do so, one could make use of external process-related data on the persons, that is, process-related data that have not been included in the actual 3MCA analysis. This approach is similar to the one taken by Vansteelandt and Van Mechelen (1998) in their triple typology analysis of binary person × situation × response data. For example, self-report or observational data could be collected on the extent to which each of the persons tend to expect to lose control when confronting physical threats (high availability/accessibility of a particular cognitive–affective expectation unit). If scores on the first person component then covaried across persons with scores on the external expectancy variable, this would suggest a possible process basis of the component in question.

ILLUSTRATIVE APPLICATION

In this section we will illustrate the relevance of the 3MCA model for a contextualized study of personality by means of an analysis of real data. The data we have collected for this purpose have been obtained with the S–R Inventory of Anxiousness of Endler, Hunt, and Rosenstein (1962). There were at least two reasons for this choice.

(1) First, S–R inventories, and in particular Endler's inventory, are of historical interest in that they have played a key role in the person–situation debate as this has flared up since the late 1960s (see e.g. Kenrick and Funder, 1988). In particular, the importance of several interactions involving the person factor has been documented in several variance component studies with these questionnaires (for a critical overview, see Furnham and Jaspars, 1983)—note that the latter interactions may be considered a formal implication of the existence of individual differences in behavioural profiles as studied in contextualized approaches to personality. Yet, whereas the variance component studies of S–R-inventory data typically resulted in magnitude estimates of the relative contributions of the respective sources of variance, many authors have criticized them because of the apparent lack of tools for a substantive interpretation of the variance components in question; in particular this concern was expressed with respect to the interactions (Bowers, 1973; Endler, 1976; Endler and Magnusson, 1976; Golding, 1975). It is precisely at this point that the 3MCA model could play a particularly useful role. Indeed, as appears immediately from equation (1), the 3MCA model is based on a sum of person × situation × response score products, and as such is ideally suited to capture and interpret various types of interaction, in addition to the respective main effects.
(2) Second, in an early paper on the 3MCA model Levin (1965) briefly reports two applications, including one with the S–R inventory of Anxiousness. We replicate and extend his study which allows us to compare our results with his.

The overall setup of the study reported below can be summarized as follows: person × situation × response questionnaire data have been collected and subjected to 3MCA analyses. We primarily focused on the substantive interpretation of the resulting model as a summary description of individual differences in response profiles across situations. In addition, the subjects that filled out the S–R Inventory have also been asked to fill out an experimental questionnaire to capture potentially relevant CAPS variables. Four types of these variables have been considered: (a) encodings, (b) competencies, (c) expectancies, and (d) values. Below, we briefly discuss each of these successively.

(a) Regarding encodings, the potential relevance of this type of CAPS variable is amply documented in appraisal theories of emotions (see e.g. Frijda, 1993; Roseman, 1991; Roseman, Antoniou and Jose, 1996). According to these theories, emotions are multicomponent phenomena that typically result from (possibly very elementary) appraisal processes of stimulus conditions. Within the context of anxiety, appraisals could, for instance, refer to how threatening stressful situations are perceived (King and Endler, 1990). Individual differences in the readiness of such perceptions are a plausible basis for individual differences in anxiety responses. This may be the case both for a global tendency to perceive stressful situations as threatening and for tendencies that concern more specific kinds of stress. As to the latter, for the present study, different types of stress as previously identified in the S–R Inventory of Anxiousness may be relevant, including social evaluation, physical danger, ambiguity, and failure. The first three are derived from two-way factor-analytic results of Endler *et al.* (1962); the fourth one directly relates to fear of failure (which does not necessarily coincide with social evaluation apprehension). We will therefore include in our study a measure of a general tendency to encode stressful situations as threatening as well as corresponding measures for the four above mentioned specific types of stress.
(b) Regarding competencies, from the perspective of an ability conception of personality (e.g. Paulhus and Martin, 1987; Wallace, 1966) anxiety responses may be considered failure behaviour, which results from a person's competencies being exceeded by situational demands (Wright and Mischel, 1987). Individual differences in anxious behaviour may therefore be attributed to differences in a competency that could be called stress immunity. Measures of the latter type of competency will be included in our study, both with regard to stress in general and to the four specific types of stress mentioned above.
(c) Regarding expectations, several authors have discussed the link between anxiety and uncertain expectations, and in particular, uncertainty about the adequacy of one's coping repertoire as well as expected lack of control (see e.g. Fiske, Morling and Stevens, 1996; Frijda, 1993). People are also known to differ considerably in their level of pessimistic versus optimistic expectations (see e.g. Scheier and Carver, 1992). CAPS measures related to pessimistic expectations (in general as well as with respect to specific types of threat) were therefore also included in our study.
(d) Finally, regarding values, a key notion in experienced emotions and emotional intensity is that of concern (this term referring to major goals, motives, etc; see e.g. Frijda, Ortony, Sonnemans and Clore, 1992; Smith, Haynes, Lazarus and Pope, 1993). In particular, a crucial determinant of emotional intensity that has been

referred to in this context is *concern strength* (Frijda *et al.*, 1992). Regarding anxiety, it seems obvious that individual differences in concern strength with respect to specific value domains may play a significant mediating role in the coming about of anxious behaviour. For instance, a physically threatening situation may elicit more and more intense anxiety responses from individuals who care more about their physical health. Value variables related to specific types of threat as well as one global variable referring to the value of a stressless life were therefore also included in our study.

Method

Subjects

Subjects were 140 first-year psychology students at the University of Leuven. Participation was a partial fulfilment of a requirement to participate in research. The sample consisted of 41 males and 99 females (which reflects the sex proportion in first-year psychology students in Belgium). The average age of the subjects was 18.6

Materials

(a) *S–R Inventory*. A Dutch translation of the S–R Inventory of Anxiousness (Endler *et al.*, 1962) was used. This inventory includes 154 items that are obtained by fully crossing a list of 11 stressful situations with 14 anxiety (and lack of exhilaration) responses. The situations are: you are just starting off on a long automobile trip; you are going to meet a new date; you are going into a psychological experiment; you are crawling along a ledge high on a mountain side; you are getting up to give a speech before a large group; you are going to a counselling bureau to seek help in solving a personal problem; you are starting out in a sailing boat onto a rough sea; you are entering a competitive contest before spectators; you are alone in the woods at night; you are entering a final examination for a very important course; you are going into a job interview for a very important job. The responses are: heart beats faster; uneasy feeling; emotions disrupt action; feel not exhilarated and thrilled; want to avoid situation; perspire; need to urinate frequently; not enjoy the challenge; mouth gets dry; become immobilized; get full feeling in stomach; not seek experiences like this; have loose bowels; experience nausea. Note that we do not want to maintain anxiety responses to be interchangeable with lack of exhilaration responses; in fact, in the 3MCA analysis they may come out as pertaining to the same or to different response components, which may be considered an interesting advantage of the approach.

(b) *CAPS questionnaire*. An experimental questionnaire was constructed that consisted of 20 variables (of three items each), intended to measure four types of cognitive–affective variable (encodings, competencies, expectancies, and values) in regard to five types of stress (global, social evaluation, physical danger, ambiguity, and failure). Encoding referred to the perception of a stressful situation as threatening, competency to feeling able to cope with stressful events, expectancy to pessimistic expectations, and values to concern strength. Examples of items include: 'I easily perceive a situation in which I may sustain a bodily injury as

being risky' (encoding, physical danger), and 'In a performance situation I easily expect to fail' (expectancy, failure).

Procedure

First the subjects had to fill out the S–R Inventory. For each item (situation–response combination) they were asked to indicate the extent to which they would show the response in the situation under study. For this purpose a five-point scale had to be used, with 5 always referring to anxiety (or lack of exhilaration, respectively); the labels of the scales depended on the response under study (e.g. for 'heart beats faster': 1 = not at all, 5-much faster). First, the subject had to judge the first situation with respect to all responses, next the second situation, etc. The order of the responses was the same for all situations and for all subjects.

Next the subjects were asked to fill out the CAPS questionnaire. The items were presented in random order (same order for all subjects). A seven-point response scale was used, with 1 = not at all applicable to me and 7 = to a strong extent applicable to me.

Analysis

(a) *Variance component estimation*. Estimates of the percentages of main effects of persons, situations, and responses as well as for all pairwise interactions were obtained from a fixed effect analysis of variance (see e.g. Endler and Hunt, 1966).

(b) *3MCA*. This type of analysis implies three kinds of choice related to: (1) a possible preprocessing of the data prior to the actual analysis, (2) the choice of the number of components for each of the three modes, and (3) the choice of a simple structure rotation. The situation parallels that of two-way principal component analysis and factor analysis, though, in general, the number of choice options is larger and the choice process itself is more complex. As to the latter, an exhaustive discussion of the practical use of 3MCA falls beyond the scope of the present paper; an extensive discussion of it is presented elsewhere (Kiers and Van Mechelen, 1999). We limit ourselves here to a brief summary of the options made in the analysis of the present data.

First, regarding a possible preprocessing of the data, one may note that model equation (1) may possibly hold only for some type of standardized data rather than for the raw observations. Given the nature of the response scales of the S–R Inventory, which bear incomparable labels, a reasonable assumption is that equation (1) holds for the data when expressed as deviations from the (unknown) neutral points of each of the response scales. As discussed by Kiers and Van Mechelen ('Three-way component analysis: principles and illustrative application', submitted manuscript), in such a case, appropriate estimates of the component scores may be obtained by analysing the data after subtracting from each entry the scale mean of the situation–response combination under study, calculated across all subjects. Moreover, given the difference in response scale labels, one may also wish to correct for unwanted differences between responses in scale range. This may be done by dividing each entry by the standard

deviation of the corresponding response scale (calculated across all pairs of subjects and situations).

Second, regarding the choice of the numbers of components (which may differ for persons, situations, and responses), various criteria could be used, including percentage of variance accounted for, a generalized scree test (Timmerman and Kiers, in press), and stability of analyses of parts of the data. The generalized scree test relies on differences in percentage of variance accounted for between neighbouring solutions, which, in the two-way component analysis case, correspond to eigenvalues. Stability may be considered an important criterion as an internal measure of generalizability of the obtained results. For the present data, a $P = 6$, $Q = 3$, $R = 4$ solution is proposed. The latter accounts for 41.1 per cent of the variance in the (preprocessed) data. According to the extended scree test, this solution corresponds to a point where adding the last component led to a considerable increase in fit, while this is not the case for adding more components. Finally, the selected model also appeared to be reasonably stable in a split-half procedure.

Third, regarding the choice of a rotation, simple structure of each of the component score matrices as well as of the core may be desirable. (Note that all four model parts cannot be simplified jointly, which implies that some compromise will be needed.) For the present data, it was decided to rotate so as to obtain simple structure for the situation and response scores as well as for the core.

(c) *Reliability check*. The reliability of the 20 CAPS variables was checked by calculating Cronbach's coefficient alpha per scale.

(d) *Correlations with CAPS scales*. Correlations across persons were calculated between the 3MCA person component scores and all CAPS scale scores.

Results

Results of the variance component estimation are presented in Table 3. There are substantive contributions for all effects and particularly large contributions for the main effect of the responses and for the residual.

Regarding the 3MCA analysis, Table 4 presents the component scores for the situations. The first situation component, with the highest scores for 'speech before large group' and 'job interview', concerns situations in which one's performance is judged by others and is therefore called *Social evaluation*. Situations scoring high on the second situation component include 'crawling along a hedge high on a mountain side' and 'starting out in a sailing boat onto a rough sea'; hence, this component can be summarized as *Inanimate danger*. For the third situation component there is only a single high scoring situation: 'being alone in the woods at night'; this component will further be labelled *Alone in woods*.

Table 5 presents the results for the response scales. The first response component is associated with a mixture of behavioural and feeling reactions, including 'not seek experiences like this' and 'not enjoy the challenge'. A reasonable summary of this component is 'not approach this situation' or, somewhat shorter, though slightly less accurate: *Avoidance*. Responses that score high on the second response component include 'heart beats faster', 'perspire' and 'mouth gets dry'; the component is therefore labelled *Autonomic physiological reaction*. The third has highest scores for 'full feeling in stomach' and 'feel nausea'; hence it is labelled *Sickness*. The responses

Table 3. Estimated variance components and variance percentages for anxiety data

Effect	Variance component	Percentage
Person	0.22	9.9
Situation	0.17	7.7
Response	0.53	23.9
Person × situation	0.25	11.1
Person × response	0.19	8.6
Situation × response	0.21	9.5
Residual	0.65	29.2

Table 4. Situation component scores for anxiety data

Situation	Social evaluation	Inanimate danger	Alone in woods
Auto trip	0.13	0.15	−0.11
New date	0.26	0.15	−0.30
Psychological experiment	0.04	0.09	0.13
Ledge high on mountain side	0.04	0.77	0.09
Speech before large group	0.49	−0.14	−0.11
Consult counselling bureau	0.25	−0.07	0.19
Sailing boat on rough sea	0.15	0.53	−0.07
Match in front of audience	0.38	0.11	−0.09
Alone in woods at night	0.09	0.05	0.89
Job interview	0.48	−0.13	−0.04
Final exam	0.46	−0.16	0.16

Note: From 'An S–R inventory of anxiousness,' by N. S. Endler, J. McV. Hunt and A. J. Rosenstein. (1962). *Psychological Monographs*, **76**, (17, whole No. 536). Copyright 1962 by the American Psychological Association. Adapted by permission of the author.

scoring high on the fourth component concern an increased need for excretion; this component is therefore labelled *Excretory need*.

Table 6 presents the correlations between the person components. Most values are moderate, with the final two components being related relatively strongly to the first three components. To interpret the person components, one may inspect the core array as presented in Table 7. Generally speaking, the highest core entries (and therefore the largest individual differences) are observed in situations scoring high on the social evaluation situation component and with respect to responses scoring high on the avoidance response component. The rows of Table 7 can further be read as summary descriptions of the 'behavioural signatures' of persons scoring high on the corresponding person components. For example, persons scoring high on the first person component do not enjoy and tend to avoid social evaluation situations. Persons scoring high on the second component tend to display an increased excretory need in all kinds of stressful situation, whereas persons scoring high on the fourth person component tend to display all kinds of anxiety response whenever a situation pertains to inanimate danger. As an aside, we also note that *t*-tests revealed significant ($p < 0.01$) sex differences on all person components (except for the second one), women always scoring higher than men.

The second from left column of Table 8 presents the reliabilities (Cronbach's coefficient alpha) for all CAPS scales. Given that each of the scales consists of three items only, the reliabilities are acceptable, with one exception: competencies—social

Table 5. Response component scores for anxiety data

Response	Avoidance	Autonomic physiological reaction	Sickness	Excretory need
Heart beats faster	0.06	0.57	−0.07	−0.18
Uneasy feeling	0.28	0.25	0.07	−0.06
Emotions disrupt action	0.18	0.20	0.23	−0.01
Not feel exhilarated and thrilled	0.46	−0.11	−0.05	−0.09
Want to avoid situation	0.41	0.11	−0.06	0.02
Perspire	0.07	0.52	−0.03	−0.03
Need to urinate frequently	−0.06	0.21	−0.03	0.48
Not enjoy the challenge	0.48	−0.09	−0.08	−0.01
Mouth gets dry	−0.08	0.36	0.00	0.32
Become immobilized	0.06	0.18	0.28	0.19
Full feeling in stomach	0.00	0.00	0.79	−0.12
Not seek experiences like this	0.48	−0.12	−0.09	0.03
Have loose bowels	0.09	−0.12	−0.09	0.72
Experience nausea	0.14	−0.18	0.45	0.25

Note: From 'An S–R inventory of anxiousness,' by N. S. Endler, J. McV. Hunt and A. J. Rosenstein. (1962). *Psychological Monographs*, **76**, (17, whole No. 536). Copyright 1962 by the American Psychological Association. Adapted by permission of the author.

Table 6. Correlations between person components for anxiety data

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5
Comp. 2	0.35				
Comp. 3	0.40	0.35			
Comp. 4	0.27	0.38	0.22		
Comp. 5	0.47	0.52	0.41	0.32	
Comp. 6	0.56	0.58	0.49	0.28	0.60

Table 7. Core array for anxiety data

	Social evaluation				Inanimate danger				Alone in woods			
Person Comp.	Avoid	Auto phys.	Sick	Excr. Need	Avoid	Auto phys.	Sick	Excr. Need	Avoid	Auto phys.	Sick	Excr. need
1	36.4	1.0	0.4	0.2	1.6	−3.4	−2.0	−1.0	2.5	−4.3	−1.7	2.2
2	0.2	0.7	−0.1	36.9	−2.9	3.5	2.4	15.2	−1.6	−0.5	3.9	12.4
3	0.5	0.1	−1.2	−0.9	0.4	2.6	−1.9	−1.9	26.4	18.5	8.4	6.6
4	0.8	−1.6	0.3	−2.2	30.2	11.1	11.8	9.0	0.4	0.4	−0.8	−2.4
5	0.4	1.0	34.9	0.2	0.4	−4.0	6.5	−4.7	−3.0	1.7	9.8	2.2
6	1.0	40.0	1.2	1.2	−2.7	11.2	0.5	−0.6	−1.2	5.0	−4.8	−7.0

evaluation. Table 8 further presents the correlations between the CAPS variables and the six component scores. In general, firstly, all person components appear to be positively related to all encoding and expectancy variables and negatively to the competencies. Most relations with the value variables are negligible. Secondly, the first person component seems to be more strongly related to most CAPS variables than the other components. Thirdly, a more fine-grained inspection of the columns

Table 8. Cronbach's alpha per CAPS scale and correlations between six person components and CAPS scales

		Person components					
CAPS variable	Alpha	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6
Encodings (perceiving situation as threatening)							
General	0.86	0.49	0.28	0.28	0.28	0.44	0.45
Social evaluation	0.89	0.46	0.27	0.33	0.23	0.42	0.43
Failure	0.83	0.58	0.27	0.15	0.25	0.43	0.41
Physical danger	0.80	0.38	0.21	0.31	0.37	0.31	0.35
Ambiguity	0.89	0.61	0.32	0.35	0.29	0.49	0.51
Competencies							
General	0.91	−0.45	−0.12	−0.24	−0.23	−0.37	−0.36
Social evaluation	0.33	−0.39	−0.13	−0.15	−0.10	−0.32	−0.35
Failure	0.80	−0.49	−0.19	−0.39	−0.20	−0.43	−0.46
Physical danger	0.84	−0.51	−0.23	−0.38	−0.33	−0.34	−0.46
Ambiguity	0.88	−0.53	−0.19	−0.34	−0.24	−0.43	−0.41
Pessimistic expectations							
General	0.88	0.48	0.24	0.24	0.24	0.44	0.41
Social evaluation	0.89	0.39	0.24	0.09	0.15	0.32	0.28
Failure	0.89	0.58	0.25	0.26	0.21	0.40	0.41
Physical danger	0.62	0.39	0.15	0.26	0.27	0.27	0.33
Ambiguity	0.84	0.45	0.21	0.24	0.24	0.45	0.43
Values (concern strength)							
Lack of stress in general	0.82	0.04	−0.14	−0.10	−0.04	−0.15	−0.12
Reaction of others	0.60	0.34	0.23	0.31	0.16	0.25	0.35
Success	0.54	0.29	0.11	0.17	−0.02	0.17	0.22
Physical condition	0.71	−0.15	−0.01	0.02	−0.07	−0.11	−0.01
Clarity	0.75	0.14	−0.05	0.14	0.08	0.02	−0.07

may reveal specific associations between person components and CAPS variables. For example, the persons scoring high on the first person component tend to perceive ambiguous situations as especially threatening ($r = 0.61$); the same holds for situations that imply a risk of failure ($r = 0.58$), which are also expected to result in failure ($r = 0.58$). As a second example, for the fourth person component, within three categories of CAPS variables the highest correlations are observed with variables pertaining to physical danger.

Discussion

The variance component estimates generally are in the range of those found earlier in studies with the S–R Inventory of Anxiousness (Furnham and Jaspars, 1983). In particular, we note a sizeable contribution of the response main effect (due to the variety of the responses included in the inventory), and nonnegligible contributions for all other sources of variance (including, in particular, the various interactions).

Regarding the 3MCA results, the first two situation components clearly reflect the distinction between social and nonsocial (inanimate) threats. The same distinction was also found by Endler *et al.* (1962) in their original paper on the S–R Inventory of

Anxiousness, in which results of two-way factor analyses on scale scores of the 11 situations (summed across responses) were reported. In particular, three factors were retained by them, the first two of which were interpreted as 'threat to interpersonal status and to the achievement of goals' and 'inanimate dangers'; according to the authors, the psychological meaning of their third factor was unclear. Moreover, for his part, Levin presents the results of a $3 \times 3 \times 3$ three-mode factor analysis of data obtained with the same questionnaire. The first two situation components found in this study, 'interpersonal stress' and 'inanimate personal danger', also are in line with our results, unlike Levin's third component of 'intrapersonal stress'. The latter might cast doubt on our third situation component, given also that it pertains to a single high loading situation only. Recall, however, that all our situation components, including the third, appeared to be reasonably stable in a split half procedure, which implies at least some internal support for their generalizability.

Regarding the 3MCA response components, a meaningful grouping of the responses was obtained, one group pertaining to behavioural/feeling responses and three groups pertaining to physiological reactions that belong to clearly distinct physiological subsystems: cardiovascular plus glands, stomach/digestive system, and excretory system. Furthermore, the response component results are also more or less in line with the results of previous studies, although our response structure is generally more refined: as such, the results of two-mode factor analyses reported by Endler *et al.* (1962) (on response scales summed across situations) include a factor resembling the avoidance factor reported in our study as well as a factor that looks like a combination of our Sickness and Excretory need factors (in addition to a general situation factor). In Levin's three-mode analysis, the first two Endler factors were also reported, in addition to a factor that somewhat resembles our Autonomic physiological reaction factor.

The core array reveals a rich picture of individual differences of various kinds. One person component (person component 4) pertains to individual differences in all types of anxiety response specifically in relation to situations that imply an inanimate, physical danger. These individual differences may be considered part of the person $\times$ situation interaction and relate to a vulnerability for one particular type of stress. Another component (person component 2) is associated with high core entries for a single response component (excretory need), across all types of stress. This type of individual difference may be considered part of the person $\times$ response interaction and pertains to a distinct form of response stereotypy (Lacey and Lacey, 1958; Sternbach, 1966): for people scoring high on this component an increased need for excretion appears to be the predominant mode for expressing their anxiety. Other components refer to specific combinations of types of stress and types of response and may therefore be associated with the person $\times$ situation $\times$ response interaction. For example, persons scoring high on the sixth component tend to display autonomous physiological responses in social evaluation and inanimate danger situations, whereas persons scoring high on the first component tend to display avoidance responses in situations that imply a social evaluation. The latter behavioural signatures may be considered to arise from the combination of a vulnerability for specific kinds of stress in conjunction with a predominance to express anxiety along specific response modes.

Finally, the correlations between the person components and the CAPS variables reveal, at least to some extent, the mediating process basis of the 3MCA structure.

First, the generally positive relations between the components and the encoding and expectancy variables and the negative relation with the competencies are in line with our hypotheses, more anxious people tending to perceive stressful situations as more threatening, tending to feel less competent to cope with them, and tending to expect worse consequences. The generally weaker relations with the CAPS scales pertaining to concern strength, which are somewhat unexpected from the perspective of studies on emotional intensity (Frijda *et al.*, 1992) may be due to the lower reliability of the variables in question. On a more refined level, from the core one may derive that persons scoring high on person components 1, 5, and 6 display various kinds of anxiety response in performance situations that imply some kind of social evaluation; as compared to other person components, these person components also display higher correlations with encoding and expectation variables concerning social evaluation, failure, and ambiguity; moreover, person components 1 and 6 also display a somewhat higher correlation with concern about the reaction of others. All this means that persons scoring high on the components in question tend to perceive uncertain, evaluative performance situations as especially threatening and as probably resulting in a bad outcome, which may account for their anxiety responses. Regarding the fourth person component, persons scoring high on it tend to display all kinds of anxiety response in situations that imply an inanimate danger. A possible process basis for this response pattern is suggested by the profile of the correlations with this person component across the different CAPS scales (whereas a comparison of these correlations with the corresponding ones for the other person components is less revealing): as noted above, for encoding, competency as well as expectancy variables, the highest correlations are observed for the CAPS scales pertaining to physical danger, in line with the specific vulnerability of the high component 4 persons. The process basis of the remaining person components is less clear. This may be due, in part, to the fact that the CAPS variables that were used in this study pertain to mediating units that are rather close to the stimulus side of the cognitive–affective process and are less relevant for a distinction between different responses as well as for an account of individual differences in response stereotypy.

CONCLUDING REMARKS

The 3MCA model, as presented in this paper as a tool for a contextualized study of personality, obviously relates to the classical models of two-mode principal component analysis and two-mode factor analysis. Recently, the use of the latter models within the personality domain has been the subject of a trenchant critique by Block (1995) who called factor analysis 'a highly useful technique for the study of personality but (...) not a method for all reasons' (p. 191). Admittedly, Block's critique has been formulated within a discussion of a decontextualized approach in the Big Five research tradition. Yet, there is no principled objection against applying two-mode PCA or factor analysis in contextualized studies of personality as well (although this is less often done in practice); the latter could, for instance, be achieved by selecting a particular response and by subsequently collecting and analysing person by situation data on the occurrence of that response in a sample of relevant situations. It seems plausible that several of Block's (1995) criticisms would also apply

within the latter context as well as with respect to 3MCA. Indeed, one of his criticisms reads that there is still no clear, unequivocal rule for deciding on the number of factors or on the optimum rotation of the set of factors once their number has been chosen. The latter obviously also holds for the 3MCA model, for which the choice of the numbers of components and of a criterion of simple structure is even more complex than in the two-mode situation. Another of Block's criticisms pertains to the linearity (actually, bilinearity) of the common factor model, which he considers not too realistic. This criticism can of course also be formulated with respect to the (trilinear) 3MCA model. The relevance of other criticisms for the 3MCA model, however, is at least arguable. For example, Block states that a factor analysis based on relations among variables across individuals, as a variable-centred approach, cannot represent a personality structure. Yet, as illustrated in this paper, 3MCA can reveal a simultaneous summary picture of the structure of inter- as well as intra-individual differences, which clearly goes beyond a purely variable-centred approach.

Another model related to 3MCA is the triple typology model developed by Leenen *et al*. (1999) and introduced within a personality context by Vansteelandt and Van Mechelen (1998). Both the triple typology and the 3MCA models are decomposition models for three-mode three-way data that can be meaningfully applied within contextualized studies of personality; clear mathematical relations between the two can be specified. A major difference is that the triple typology model is a discrete (categorical) model for discrete (binary) data, whereas the 3MCA model is a continuous model for continuous (rating) area. A further distinctive feature of the triple typology model is that it may reveal asymmetric, hierarchical relations between person, situation, and response types.

A key issue in the application of both the triple typology and the 3MCA model to personality data is the choice of the elements of the three modes, that is, persons, situations, and responses. (A related concern was also expressed by Block (1995) within a two-mode context.) More fundamentally, as pointed out by Wright and Mischel (1987) and Mischel and Shoda (1995), a crucial step in the study of any subdomain of personality functioning involves the identification of relevant active situational features and response characteristics. One possible approach for doing so has been illustrated in the present paper; it comes down to inducing relevant situation and response features from the data. An advantage of this approach is that it may allow for the identification of hitherto unknown features. Such an inductive approach should, however, be complemented by a more deductive one that makes use of conceptually pre-structured situation and response materials, for instance based on some facet-theoretic design. The latter type of approach may also facilitate the selection of possibly relevant CAPS variables that constitute the process basis underlying the 3MCA or triple typology structure.

Finally, with regard to the CAPS variables, in this paper as well as in that by Vansteelandt and Van Mechelen (1998), first a summary descriptive model for individual differences in behavioural profiles was constructed, which was subsequently related to external process-related variables, the latter not being involved in the construction of the model itself. An alternative approach may consist of a simultaneous analysis of behavioural and process-related data. Several potentially suitable models for such an analysis may be considered (see e.g. Carroll, Pruzansky and Kruskal, 1980; Smilde and Kiers, 1999). Their use and extension is a challenge for future personality research.

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