A short form of the Positive and Negative Affect Schedule: evaluation of factorial validity and invariance across demographic variables in a community sample

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Abstract

The existence of two nearly-orthogonal dimensions of positive and negative affect was established for a ten-item short form of the Positive and Negative Affect Schedule using confirmatory factor analytic techniques in a large probability sample (n = 2651) spanning ages 18 to 79. The factor structure and factor correlations were found to be unchanged with age. A multiple indicators, multiple causes model was used to investigate differences in item responses according to age, sex, education, marital status and financial hardship that could not be accounted for by differences in affect levels between groups. Only one item, ‘excited’ from the Positive Affect scale, was found to elicit differential responses. While improvements to the Positive Affect scale might be desirable, the Short PANAS can be recommended for use when measures of positive and negative affect are required. © 1999 Elsevier Science Ltd. All rights reserved.

1. Introduction

The assessment of subjective well-being (SWB) is an important aspect of many psychological and sociological investigations. Diener (1994) defines SWB as being comprised of two components, one hedonic or affective level and the other, cognitive appraisal of satisfaction with life. In many settings these components are concordant but they have different correlates and are subject to differential change over time. This paper focuses on the measurement of affect rather than on the cognitive appraisal of satisfaction with life. An almost universal finding in multiple item measures of affect is the existence of two dimensions, reflecting positive and negative affect (PA and NA).
In most studies, these dimensions have been found to be independent or, at best, only weakly correlated (see Diener & Emmons, 1984).

One of the most widely used instruments in this field is the Positive and Negative Affect Schedule (PANAS) (Watson, Clark & Tellegen, 1988). The PANAS consists of 10 positive adjectives and 10 negative adjectives. Respondents are asked to rate a number of adjectives according to the extent to which each describes the way they have felt during a specified time. In past research, subjects have been asked to consider a wide range of time frames in making their assessments (e.g. today, the past two weeks, in general). While scale scores increase as a function of the period rated, the gross characteristics of the instrument (internal consistency and scale correlations) appear to be robust with respect to rating instructions (see Watson & Clark, 1994).

In a study of affect in the elderly, Kercher (1992) created a short form of the PANAS, choosing five items from each scale on the basis of a circumplex model developed by Larsen and Diener (1992). The circumplex model implies that adjectives fall on a spectrum between the positive and negative dimensions rather than simply clustering on one or other factor. Adjectives were chosen by Kercher to reflect pure measures of the two constructs. These items were used in a confirmatory factor analytic study of the elderly (mean age 78.5 years). As well as having promising psychometric properties, such a brief instrument has the obvious attraction of minimising demands on respondents in lengthy surveys. Kercher demonstrated that the items chosen fitted the two-factor structure found using longer instruments in generally younger populations. Larsen and Diener (1992) suggested that the PANAS might be unsuitable for use in older groups because they predicted that the positive and negative affect scales would be substantially correlated in the elderly. However, Kercher found that the two factors were relatively independent. More recently, an exploratory factor analysis of a Swedish translation of the Short PANAS in the very old by Hilleras, Jorm, Herlitz & Winblad (1998) substantially replicated the findings of Kercher.

Research currently available makes the Short PANAS an attractive candidate for the measurement of SWB in situations in which brevity is important. However, research using the five-item scales has been undertaken only with elderly participants, despite there being considerable interest in the measurement of affect across the life span. Thus, before the Short PANAS can be recommended for general use, there is a need to determine its ability to measure the constructs of positive and negative affect without bias across a range of demographic variables including age.

Because measures of affect reflect internal state rather than assessing objective indicators of quality of life, interest must lie in correlates of the measures and comparing positive and negative affect levels between groups. Under these circumstances, the measurement properties of any instrument used to assess any component of SWB become critical (Horn & McArdle, 1992). While levels of positive and negative affect may vary between groups, it is important to establish that the scales used are measuring the same attributes across different groups. That this may not be the case is illustrated by the analysis of a large sample of responses to a number of well-being scales by Carp & Carp (1983). They undertook multiple exploratory factor analyses of several scales in strata defined by age and sex. Few items from the scales used were found to form factors invariant across these strata. Carp and Carp noticed that items comparing current with previous states were functioning differently according to age. The difficulty of constructing items that involve appraisal of satisfaction so they are interpreted identically by persons of differing age, sex and other demographic characteristics would seem almost insurmountable. Differences in interpretation may be less of a problem for measures that require responses to single adjectives, but this has not been
established. Lawton, Kleban & Dean (1993) present data that show differences in mean adjective item endorsement as a function of age. Such differences allow the possibility of item-specific differential responses but may be accounted for by age differences in positive and negative affect.

Invariance of the structure of an instrument and the relationships between the latent variables it measures are central attributes of an instrument (see Carp & Carp, 1983; Horn & McArdle, 1992). These measurement properties can be investigated using straightforward confirmatory factor analytic techniques. An equally important question, but one that is frequently ignored or poorly addressed, is whether respondents having the same position on the latent variable measured by an item respond identically to that item. When respondents from different subgroups in a population respond differently to an item, such an item is said to be biased or to exhibit differential item functioning (DIF). DIF is most commonly investigated in the assessment of ability. As a result of this, most approaches to investigating DIF are restricted to binary items (correct, incorrect) (cf. Hambleton & Swaminathan, 1985). It is important to realize that simply examining differences in mean responses between subgroups does not address this question. Any differences found will reflect real differences on the latent trait as well as differential responses to the item by persons at the same level on the latent trait.

Gallo, Anthony, and Muthén (1994) demonstrated how a particular type of covariance structure model could be elaborated to assess the extent to which respondents’ characteristics influenced responses to individual items. The Gallo et al. (1994) application was to depressive symptomatology, but the model is readily adapted to self-report questionnaires of any emotional states. Figure 1 shows the form of the model as applied to the PANAS. The core of the model consists of the two-factor measurement model for the Short PANAS positive and negative affect latent variables. Five demographic covariates including age, sex and marital status were included in the model as predictors of the two latent variables. This class of model is referred to as a multiple indicator, multiple causes (MIMIC) model (Muthén, 1988; Gallo et al., 1994). Because all these variables are directly measured (i.e. a single indicator, presumed free of measurement error, is used to measure each construct), this part of the model may be thought of as a multiple regression of the two latent variables against the covariates.

In this model, differential effects of a covariate (e.g. age) are assessed by a direct path from the covariate to an item. If, for example, older respondents are more likely to report being inspired than are younger respondents with the same level of PA, a significant positive coefficient will be observed (a in Fig. 1) on the path from age to inspired. This effect can be detected even if, overall, there is a decline in PA with increasing age. The latter effect being evidenced by a negative coefficient (β in Fig. 1) on the path from Age to PA.

The general aim of this study was to assess the Short PANAS as a measure of positive and negative affect that is capable of application without bias across the life span.

2. Method

2.1. Participants

Participants were recruited from the Electoral Roll for Canberra, Australia. Enrolment to vote is compulsory for all Australian citizens aged 18 or over. Interviews were completed with 2725
Fig. 1. MIMIC model for simultaneously assessing the effects of demographic variables on PA and NA and differential effects on PANAS items. (For clarity, unique variance components of each PANAS item and the free correlations between the covariates are not shown.)

individuals, representing a response rate of 67% from those who were contactable. Demographic data or responses to items on the PANAS were missing for a small number of respondents so analyses are reported for the 2651 respondents for whom complete data were available. Of these respondents, 1262 were male and 1389 were female. Their mean age was 42.42 (S.D. = 14.00, range 18–79).

2.2. Survey procedure

Persons selected at random from the Electoral Roll were sent a letter informing them about the survey and saying that an interviewer would contact them soon to see if they wanted to participate. If a person agreed to participate, the interviewer visited them at a convenient location, usually the
participant’s home. Participants were asked to complete a questionnaire that included socio-demographic characteristics and the Short PANAS. Each respondent was asked to read the PANAS adjectives and to respond according to the “extent you feel this way in general”. The Likert scale specified by Watson & Clark (1994) was used for responses.

Other self-report questionnaires were also completed but are not considered in this study. To ensure anonymity and encourage frank responses, the questionnaire had an ID number, but not the participant’s name. After completing the questionnaire, the participant sealed it in an envelope and gave it to the interviewer who never saw the answers given.

2.3. Analysis

Modelling was undertaken in three phases. First, a confirmatory factor model was fitted to the data as a whole. The purpose of this analysis was to determine whether the model developed by Kercher (1992) could be applied in the current sample. Second, the confirmatory model was fitted simultaneously to four groups defined by age. The primary purpose of this analysis was to examine the magnitude of the correlation between the latent variables PA and NA as a function of age. Differences in patterns of loadings and error variance between age groups were also investigated. The third phase of the analysis involved the fitting of the MIMIC model described above to the confirmatory model for the PANAS items.

Maximum likelihood parameter estimates for all models were obtained using AMOS 3.6.1 (Arbuckle, 1997). In addition to the chi-square test, goodness of fit was evaluated using the goodness of fit index (GFI) (see Arbuckle, 1997), the Bentler and Bonnett (1980) non-normed fit index (NNFI, also referred to as the Tucker–Lewis index) and the root mean square error of approximation (RMSEA) (Browne & Cudeck, 1992). The NNFI indicates how well a model fits, relative to a model specifying no relationships between any of the variables. Values of the GFI and NNFI greater than 0.90 are indicative of well-fitting models (see Marsh, Balla, & McDonald, 1988). Work by Rigdon (1996) has demonstrated the utility of the RMSEA as an index of the degree to which a confirmatory structure approximates the data being modelled. Browne and Cudeck (1992) have suggested that values of 0.05 and below indicate a close fit of the model and that values of the RMSEA between 0.05 and 0.08 indicate a reasonable error in approximating a given structure. Browne and Cudeck also provide a test of the hypothesis that the population RMSEA for the model is no greater than 0.05. Failure to reject this hypothesis at conventional significance levels provides further support for the model as a close fit to the data.

Because maximum likelihood estimation is based on a multivariate normal model, there was concern that standard errors produced under this method may not be accurate. Therefore confidence intervals reported here were obtained by bootstrapping using 500 resamplings from the original sample.

2.4. Measurement of demographic characteristics

For the MIMIC model only scaled or dichotomous covariates could be accommodated (see Bollen, 1989). Questions in the survey not yielding such data were therefore recoded as follows: marital status was classified as being currently married versus never married, separated or widowed. Education was dichotomized to contrast those having tertiary education from those who did not.
The more interesting comparison of those having a poor education (only primary or elementary secondary schooling) was not feasible because of the format of the survey questions and the distribution of responses. Financial hardship was indicated by the endorsement of “Yes, often” in response to a question concerning going without necessities due to lack of money. While seen as desirable, it was not possible to include employment status as a variable due to the small number of respondents reporting being unemployed. Most analyses entered age as a continuous measure. Where required, four age groups, each spanning approximately 15 years, were formed. Cell sizes of all categorizations are shown in Table 1.

3. Results

Means for the Positive and Negative Affect scales for the subgroups defined by the demographic covariates are shown in Table 1. Higher levels of PA were associated with being younger and better educated. Higher levels of NA were associated with being younger, female, not having a tertiary
education and with reporting financial hardship. These differences must be assessed with caution, because relationships among the demographic variables are not taken into account by this analysis. Cronbach’s alpha was 0.78 for PA and 0.87 for NA for the whole sample. Little variation in internal consistency was noted when alpha was calculated separately for each age group. Alphas for PA were 0.75, 0.79, 0.78, and 0.72 for the youngest to oldest age groups. For NA, alphas for each age group were 0.86, 0.87, 0.88 and 0.86, respectively.

3.1. Whole-sample confirmatory factor analysis

The two factor model was fitted to the full sample data. Loadings on each factor were defined by the scale membership for each item. The two factors were allowed to freely correlate. While two goodness of fit indices indicated an adequate fit of the model to the data (GFI = 0.942; NNFI = 0.903) the chi-square ($\chi^2 = 767.982$, df = 34, $p < 0.0000$) and the RMSEA (RMSEA = 0.090, Pr(RMSEA $\leq 0.05$) = 0.00) suggested improvement might be possible. Allowing the residuals of two item pairs to correlate (distressed and upset; scared and afraid) resulted in a dramatic drop in chi-square and agreement between all measures of fit ($\chi^2 = 294.549$, df = 32, $p < 0.0000$; GFI = 0.978; NNFI = 0.963; RMSEA = 0.052, Pr(RMSEA $\leq 0.05$) = 0.052). The resulting model is shown in Fig. 2. Loadings of items on their respective factors were all statistically significant and substantial with a median loading in excess of 0.70.

Further substantial rational improvements to fit could be achieved only by allowing ‘excited’ to load on NA as well as PA ($\chi^2 = 128.665$, df = 31, $p < 0.0000$; GFI = 0.990; NNFI = 0.986; RMSEA = 0.034, Pr(RMSEA $\leq 0.05$) = 1.0). Although this represents a considerable improvement in fit, the loading was not large (0.24), lying outside the range of other loadings of items on their proper factors. Thus the model with this cross-loading was not used as the basis of further testing.

There was a statistically significant but small correlation between NA and PA ($r = -0.10$, CI = $-0.163$ to $-0.048$). In order to test the fit of a model in which PA and NA were uncorrelated, this parameter was fixed to zero. The change in chi-square was significant ($\chi^2 = 18.695$, df = 1, $p < 0.0000$) but other goodness of fit indices were not appreciably reduced by this change.

3.2. Analysis of age-group subsamples

Confirmatory factor analysis may be extended to simultaneous modelling of data from several subgroups. This feature was used to examine the pattern of correlation between NA and PA as a function of age. The sample was divided into four age groups (as shown in Table 1) and a series of models based on the two-factor model developed above was applied to these subsamples. In the first model the same structure applied across age groups, but model parameters were permitted to vary between groups. Although having a significant chi-square, this model fitted the data in the multiple group format ($\chi^2 = 425.144$, df = 128, $p < 0.0000$; GFI = 0.969; NNFI = 0.958; RMSEA = 0.030, Pr(RMSEA $\leq 0.05$) = 1.0). There was no consistent tendency for the correlation between PA and NA to increase as a function of age (correlations were $-0.099$, $-0.114$, $-0.185$, 0.056 respectively). Constraining these correlations to be equal in all groups resulted in a non-significant increase in chi-square ($\chi^2 = 6.088$, df = 3, $p = 0.1074$). Constraining all factor loadings to be equal across groups also resulted in a non-significant increase in chi-square ($\chi^2 = 29.413$, df = 30, $p = 0.4960$). Constraining all error variances to be equal, implying complete identity of the
models across age groups was, however, not supportable: the increase in chi-square being large and significant ($\chi^2 = 132.531$, df = 30, $p < 0.00001$).

3.3. Differential effects model

While demonstrating some important measurement properties of the PANAS, the multiple group approach is extremely limited in the number of covariates whose effects on the PANAS can be studied. If the effects of other socio-demographic variables on the PANAS are to be studied by this method, repeated multiple group models must be investigated or groups must be defined by combinations of the variables concerned. The first approach fails to control for dependencies.
between variables, while the second requires impractical sample sizes and can result in uninterpretable results unless no or few effects of the covariates are found. Furthermore, neither approach can differentiate the effects of a covariate on the latent variable from the effect of the same covariate on an item.

The MIMIC model discussed above and shown in Fig. 1 was fitted to the data. The demographic variables added were permitted to correlate freely and paths from the demographic variables ran to each latent variable and to all items. As the direct covariate-item paths are measuring a differential effect, one path on each latent variable must be constrained to zero. The item fixed on each scale (‘determined’ for PA and ‘afraid’ for NA) was chosen by applying the model to only one item at a time and selecting an item for each scale having no significant associations with any covariate. This simplified interpreting the parameters in the model. Because it was based on the original measurement model, overall fit remained acceptable ($\chi^2 = 281.684$, df = 32, $p < 0.0000$; GFI = 0.986; NNFI = 0.923; RMSEA = 0.054, Pr(RMSEA ≤ 0.05) = 0.109). Model parsimony could be improved by deleting paths with non-significant parameters. When this was done it did not substantially affect the remaining paths but did improve fit indices that penalize additional parameter usage.

Path coefficients and 95% confidence intervals are shown in Table 1. It can be seen that Positive Affect decreases with age and is higher for those with a post secondary education. Sex (being female) and reporting financial hardship were associated with increased Negative Affect.

With the exception of ‘excited’, direct effects on items were scattered. Age was positively associated with ‘alert’ while sex (being male) was associated with ‘nervous’ and financial hardship with ‘upset’. Age, being married and having a tertiary education all reduced endorsement of ‘excited’ differentially to an extent that could not be accounted for by the effect of these variables on Positive Affect.

4. Discussion

Analysis of responses to the 10-item PANAS substantially confirm the findings obtained by Kercher (1992) in a sample restricted to the old-old. Analysed in one group, the two-factor structure of the items was confirmed. There is a statistically significant, but very small correlation between the PA and NA factors. Multiple group analyses demonstrated that factor loadings (but not error variances) are invariant over the life span. Most importantly, the correlation between NA and PA does not change with age. The reliability of both short form scales remained acceptably high. Cronbach’s alpha for the PA scale was only lower than the values reported by Watson et al. (1988) while the alpha for the NA scale fell within the range of values reported for the full scale. The latter result is probably due to the selection for the short form of two item pairs with high inter-item correlations.

Few differences in positive affect were found between subgroups studied, with increasing age and not having a tertiary education being associated with lower levels of PA. Higher levels of NA were associated with more demographic variables including being younger, female, not having a tertiary education and financial hardship. However, when these covariates were included simultaneously in the MIMIC model, only sex and hardship were significant.

While the analyses confirm the overall structure of the Short PANAS, they also suggest that a
Table 1
Standardized path coefficients and 95% confidence intervals for covariates on PANAS factors and items

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Sex</th>
<th>Marital status</th>
<th>Education</th>
<th>Financial hardship</th>
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<tr>
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<td></td>
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<td>0.04</td>
<td>0.07</td>
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<tr>
<td></td>
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<td>(0.00−0.11)</td>
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<tr>
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<td></td>
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<td>Inspired</td>
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<td>−0.03</td>
<td>−0.01</td>
<td>0.03</td>
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<td>−0.01</td>
<td>−0.02</td>
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<tr>
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<td>(−0.09−0.00)</td>
<td>(−0.06−0.08)</td>
<td>(−0.10−0.04)</td>
<td>(−0.12−0.15)</td>
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<td>Excited</td>
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<td>−</td>
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<td>−</td>
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<td></td>
</tr>
<tr>
<td>Afraid*</td>
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<td>−</td>
<td>−</td>
<td>−</td>
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<td>Upset</td>
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<td>0.05</td>
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<tr>
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<td>(−0.13−0.05)</td>
<td>(−0.16−0.01)</td>
<td>(0.00−0.30)</td>
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</table>

* Paths from the demographic variables to these adjectives were set to zero so as to form reference item for each scale.

The number of refinements to the scale might be desirable. This study mirrored Kercher’s in requiring the fitting of correlated residuals for item pairs for NA. While Kercher fitted a correlation only to afraid–scared, allowing a correlation between upset–distressed resulted in an additional similar level of improvement in the current sample. The necessity to fit these terms to the model reflects Kercher’s choice of items from the full PANAS that were originally recognised as being pairs by Watson et al. (1988). The correlated residual terms demonstrate empirically that the words in each pair overlap in response to a greater extent than can be accounted for by their power to reflect levels of NA. The stability of the factor loadings on NA with and without the correlated residuals fitted suggests that this excess covariance between items does not markedly interfere with the structure of the NA factor. However, because it signals that significant redundancy exists within each pair, something that can be seen by simply considering the meanings of the items, the
opportunity exists to replace one word of each redundant pair with an alternative that helps to measure the breadth and range of the NA construct.

Effects of differential response to individual items were sparse and relatively modest. For NA, only the direct paths from financial hardship to upset and sex to nervous were statistically significant. Thus, at a given level of NA, those with frequent financial problems were likely to report being upset compared to those without such problems. Similarly, at a given level of NA, females were less likely than males to report being nervous. This result may strike many researchers as counterintuitive, however it illustrates the importance of using a model that can detect DIF over simply examining raw correlations or mean differences. The observed relationship does not imply that males are more likely than females to report being nervous. The reverse is the case. There is a significant relationship between sex and NA with females being higher on NA. This difference in level on the latent variable accounts for the higher observed mean response to the ‘nervous’ item, with the direct path indicating that for a given level of negative affect, females are less likely to report being nervous.

For PA, differential responses to items were also sparse, with the exception of ‘excited’. For given levels of PA, the old, those married and those with a tertiary education were less likely to report being excited. It should be noted that these effects are relatively small. However, taken in conjunction with the cross loading of ‘excited’ on NA and the results of the exploratory factor analysis of the Swedish short PANAS (Hillerås et al., 1998), there are grounds to suggest that a replacement for this item should be sought from the ‘pool’ of adjectives that comprise the complete PANAS.

Taken together, these analyses suggest that the structural characteristics of the positive and negative affect are remarkably robust to differences in age, sex and other demographic variables. The most important consequence of this finding is that differences in scale scores between subgroups such as those reported in Table 1 can be taken to reflect actual differences in the location of such groups on the construct concerned rather than reflecting artefactual differences in item response. Given the wide use of the full PANAS there would be considerable merit in repeating the analyses reported here on the full schedule.

A limitation of the analyses reported here is that interactions between demographic variables have not been included as potential predictors to differential response to items. The primary reason for not investigating such effects was the large number of possible interactions and the difficulty of representing them within the model framework used. Given the magnitude of the differential effects found, it is highly unlikely that interactions either statistically significant or substantial in size would be found. However, there may be merit in searching for interactions between predictors of PA and NA. This should be undertaken with the PA scale revised as suggested.

In conclusion, the results of our analysis replicate the two factor structure of the Short PANAS as described by Kercher in a sample restricted to the old-old. Most importantly, there was no evidence of any tendency for the separate dimensions of positive and negative affect to collapse into one bipolar dimension with increasing age. There is some evidence of differential effects on individual items as a function of age and other demographic variables, but the magnitudes of these effects are generally small. The item ‘excited’ was, however, found to exhibit a number of undesirable measurement properties. The inclusion of paired items on the NA has introduced redundancy into this scale and possibly reduced its breadth of measurement. A search for better items from the pool of adjectives in the full PANAS should be a research priority.
References


