Construct, concurrent, and discriminant validity of Type D personality in the general population: Associations with anxiety, depression, stress, and cardiac output

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Abstract

The Type D personality, identified by high negative affectivity paired with high social inhibition, has been associated with a number of health-related outcomes in (mainly) cardiac populations. However, despite its prevalence in the health-related literature, how this personality construct fits within existing personality theory has not been directly tested. Using a sample of 134 healthy university students, the present study examined the Type D personality in terms of two well-established personality traits; introversion and neuroticism. Construct, concurrent, and discriminant validity of this personality type was established through examination of the associations between the Type D personality and psychometrically-assessed anxiety, depression, and stress, as well as measurement of resting cardiovascular function. Results showed that while the Type D personality was easily represented using alternative measures of both introversion and neuroticism, associations with anxiety, depression, and stress were mainly accounted for by neuroticism. Conversely, however, associations with resting cardiac output were attributable to the negative affectivity-social inhibition synergy, explicit within the Type D construct. Consequently, both the construct and concurrent validity of this personality type were confirmed, with discriminant validity evident on examination of physiological indices of well-being.

Keywords: Type D personality, health, neuroticism, introversion, cardiac output

Theories of personality have an extensive history, with the human temperament long purported to be related to physical health. Personality theories have emanated from all areas of psychology, including cognitive psychology, psychoanalysis, and social psychology. However, perhaps the most productive source has been the psychometrically driven tradition of typologies and traits. Where typological theories of personality categorise individuals into discrete types, trait theories are based on the premise that all personalities can be identified on the basis of scores within a number of traits. Classically, the trait models of Eysenck (1991) and of Costa and McCrae (1992) are among those to have received the most research interest. Eysenck's three-factor approach posits that human personality can be encapsulated in the combination of neuroticism, extraversion, and psychoticism, while Costa and McCrae's "big five" swaps psychoticism for openness, agreeableness, and conscientiousness.

Recently, however, a personality type known as Type D has shown strong and lasting links to a range of negative health outcomes following coronary events (Denollet, Sys, & Brutsaert, 1995), including death (Denollet et al., 1996), second myocardial infarction (Denollet, Vaes, & Brutsaert, 2000), poor quality of life (Pedersen, Holkamp et al., 2006), and higher rates of depression and anxiety (Denollet, 1998a; Pedersen, Ong et al., 2006). While some have argued that Type D and depression overlap, studies have shown the Type D personality to be an independent predictor of poor coronary outcome, independent of depression (for example, see Schiffer et al., 2005). Even with the advent of technological advances in the treatment of cardiovascular disease (such as the use of percutaneous coronary interventions) the Type D personality is still associated with poor health-related outcome (e.g., Pedersen, Daemen et al., 2007; Pedersen, Denollet, Ong, Sonnenschein et al., 2007; Pedersen, Denollet, Ong, Serruys et al., 2007). Within non-cardiovascular patient populations and healthy individuals the Type D personality still shows links with poor physical and mental health (Mols & Denollet, 2010; Williams et al., 2008).

Although the Type D personality is treated as a type, it too involves the examination of (two) traits, namely negative affectivity (NA) and social inhibition (SI). Moreover, these two traits themselves appear as though they may overlap with the two traits most prominent in mainstream personality theory, namely neuroticism and extraversion. Although the prognostic power of scores for Type D within cardiac populations is well established (e.g., Denollet, 1998a; Denollet et al., 1995; Denollet et al., 1996; Pedersen, Daemen et al., 2007; Pedersen, Denollet, Ong, Sonnenschein et al., 2007; Pedersen, Denollet, Ong, Serruys et al., 2007; Pedersen, Holkamp et al., 2006; Pedersen, Ong et al., 2006), virtually none of the research tests whether Type D scores are unique predictors beyond mainstream personality traits.

The proponents of Type D have referred to this criticism as the question of whether Type D represents “old wine in new bottles” (Denollet & Van Heck, 2001, p. 467) and have responded by pointing to the importance of the proposed synergy between NA and SI, and by presenting empirical evidence that they suggest demonstrates the discriminant validity of Type D over related traits. While the NA-SI synergy does emerge as the important predictor (rather than either trait alone), it is questionable whether the empirical evidence offered for the discriminant validity of Type D over extraversion and neuroticism truly tests the comparative worth of the two conceptualisations.

For example, in a study of 155 healthy employees, De Fruyt and Denollet (2002) found half of the variance of both NA and SI to be predicted by five-factor model dimensions, with NA showing strong positive associations with neuroticism (r = +.74) and SI showing strong negative associations with extraversion (r = -.61; to a lesser extent, both NA and SI showed significant associations with conscientiousness and agreeableness). The authors identified that the Type D personality was a significant predictor of somatic complaints, sleeping problems, anxiety, and depression, even when the five-factor traits were controlled. However, although the authors presented data to show that neuroticism and extraversion accounted for only a small proportion of variance in Type D scores themselves, they did not test (a) whether neuroticism and extraversion would have predicted health outcomes when Type D variables were controlled; or (b) the comparative strengths, in multiple regressions, of Type D and extraversion-neuroticism as predictors of health outcomes.

Therefore, although De Fruyt and Denollet (2002) concluded that their findings did not argue for a replacement of the Type D personality, this appeared to be more on the basis of psychometric practicability (as the various Type D questionnaires are much shorter than typical measures of neuroticism and extraversion) than on predictive or criterion validity. It is important to note, however, that De Fruyt and Denollet's research compellingly demonstrated Type D elements to have overlapped substantially with neuroticism and extraversion, supporting its construct validity, but also identifying the potential for Type D to be confounded by neuroticism and extraversion.

The objective of the present study was to examine whether the classification of Type D personality using a traditional Type D scale (the DS16) overlaps significantly with an analogous classification based on scores for neuroticism and extraversion. The specific trait model employed as the framework for this examination is the three-factor model of Eysenck (1991). In this model, it is argued that most personality types can be represented by variations in scores for neuroticism and for extraversion (with a minority of the population further represented by scores for psychoticism). This was felt to be a more comprehensive overlap with the Type D personality than that offered by Costa and McCrae's (1992) five-factor model, which posited additional unique (albeit minor) roles for conscientiousness, openness, and agreeableness. For the purposes of clarity in the present study, we label the classification of personality using scores for extraversion (low) and neuroticism (high) as Type "E", in deference to Eysenck's authorship of the three-factor model and in order to resonate with the standard nomenclature for Type D. We retain the quotation marks in order to denote the contrived and ephemeral nature of the typology.

As well as examining the superficial overlap between Type D and Type "E" classifications, we explore the comparative predictive validity of each in terms of some mental and physical health indices in a sample of healthy adults (namely, anxiety, depression, perceived stress, and resting cardiovascular function). Elevated resting blood pressure and heart rate, including within the normotensive range, is a significant risk factor for essential hypertension and cardiac disease (see Treiber et al., 2003), even in the absence of pre-existing cardiovascular disease (Fox et al., 2007). In addition, resting cardiovascular function is also positively associated with both cardiac and non-cardiac mortality (e.g., Kannel, Kannel, Paffenbarger, & Cupples, 1987; Reunanen et al., 2000). Consequently, in examining the Type D personality in this non-cardiac sample, associations with resting cardiovascular function, an objective indicator of health status, allows examination of the predictive validity of this personality type, on both subjective and objective indicators of psychological and physical health. Therefore, the present study aims to establish the degree to which standard Type D classification offers unique predictive validity for health outcomes beyond that offered by mainstream personality theory, and thus to establish whether Type D really is "old wine in new bottles".

Methodology

Participants

One hundred and thirty four students of Psychology participated in this study in return for course credit. Participation in this study was voluntary and anonymous. All participants signed an informed consent form and were fully debriefed following the completion of data collection. The sample included 105 females ranging in age from 18 years to 36 years (M = 20.14, SD = 2.82) and 29 males ranging in age from 18 years to 35 years (M = 22.72, SD = 4.67). Males were significantly older than females, $t(33.83) = 2.83$, $p = .008$. Ethical approval was obtained from the institutional research ethics committee.

Design

This study incorporated a simple between-subjects design. The independent variable was personality with two levels; Type D and non-Type D or alternatively, Type “E” and non-Type “E”. Although initially devised as a taxonomy it has been suggested that the Type D construct is best represented as a dimensional rather than a categorical construct (Ferguson et al., 2009). Consequently, a continuous measure of Type D or Type “E” was computed using the arithmetic product of the two subscores (see Whitehead, Perkins-Porras, Strike, Magid, & Steptoe, 2007; Williams, O'Connor, Grubb, & O'Carroll, in press). Both categorical classification of Type D status and continuous measurement of the Type D construct were used in analyses. The dependent variables were scores for anxiety, depression, and perceived stress, as well as resting measures of cardiovascular parameters (namely, systolic blood pressure [SBP], diastolic blood pressure [DBP], heart rate [HR], cardiac output [CO], and total peripheral resistance [TPR]).

Materials and Apparatus

The 16-item Type D scale (DS16).

The DS16 was used to assess Type D status. The DS16 comprises of two 8-item subscales which measure NA and SI. Participants respond on a 5-point Likert scale from “False” to “True” to a range of statements such as *I am happy most of the time* and *when socializing, I don’t find the right things to talk about*. Previously, Cronbach’s α of .89 for the NA scale and .82 for the SI scale have been reported (Denollet, 1998b). The construct and external validity of this scale has been established (Denollet, 1998b) with the NA scale shown to be related to the neuroticism scale of the EPQ (r = +.64) and to the anxiety scale of the Taylor Manifest Anxiety Scale (Taylor, 1953; r = +.62). The SI scale of the DS16 is inversely related to the extraversion scale of the EPQ (r = -.65) and the Minnesota Multiphasic Personality Inventory (Johnson, Null, Butcher, & Johnson, 1984; r = -.61). Traditionally a median split on both subscales of the DS16 is used to identify Type D status, with individuals scoring above the median on both scales identified as Type D (Denollet, 1998a).

Eysenck Personality Questionnaire (EPQ).

The Revised EPQ (Eysenck & Eysenck, 1991) was used to assess Type “E” status. The EPQ consists of four different subscales measuring Neuroticism (N), Extraversion (E), Psychoticism, and a Lie scale. The scales consist of 133 questions to which the participant responds either “yes” or “no”. Satisfactory reliability for the “E” and N scales has been reported (Caruso, Witkiewitz, Belcourt-Dittloff, & Gottlieb, 2001; Williams, 1989). For clarity in the present study, scores on the “E” scale were reverse-coded in order to represent an introversion (I) score; thus ensuring that the trait conceptually resembles the SI element of the Type D personality. A median split on both N and I was used to identify Type “E” individuals: in other words, while Type D proponents suggest that persons above the median in both NA and SI (namely, Type D persons) are at particular risk of adverse health, in the present study this classification is compared with an analogous classification of persons above the median in N and I (namely, Type “E” persons).

Hospital and Anxiety Depression Scale (HADS).

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was used to assess anxiety and depression. The HADS is a 14-item scale that provides a brief state measure of both anxiety and depression. Participants respond to statements on a 4-point Likert scale, with different response items for each question. Total scores range from 0 to 21, with a higher score indicating a higher level of anxiety or depression. Previous research has reported Cronbach’s α of above .90 for both subscales (e.g., Moorey et al., 1991). Concurrent validity was previously established by comparison with 5-point psychiatric rating scales of anxiety and depression for 100 medical out-patients (Zigmond & Snaith, 1983) while the construct validity of the scale as a measure of the two factors was confirmed in a factor analysis of the responses of cancer patients by Moorey et al. (1991). In the present non-clinical sample, Cronbach's α for the anxiety scale was .82 and for the depression scale was .74.

Perceived Stress Scale (PSS).

Perceived stress was assessed using the Perceived Stress Scale (PSS; Cohen & Williamson, 1988), a 10-item scale which assesses the degree to which situations in one's life are appraised as stressful. Items are scored from 0 to 4, with a possible range of scores from 0 to 40; a higher score indicating more perceived stress. Cronbach's α of .78 has been demonstrated (Cohen, Kamarck, & Mermelstein, 1983). Concurrent validity was established in studies of college students where modest correlations with 'impact of life events' were reported (Cohen et al., 1983). The PSS was also found to correlate with indices of depressive symptomatology (r = +.65 to +.76). Use of the PSS-10, rather than the PSS-14 has been suggested because of its good internal reliability and equivalent value in predicting outcomes (Cohen & Williamson, 1988). For the current sample Cronbach's α for this scale was .85.

Cardiovascular monitoring equipment.

Cardiovascular function was measured using a Finometer haemodynamic cardiovascular monitor (Finapres Medical Systems BV, BT Arnhem, The Netherlands). The Finometer is the successor to the TNO Finapres-model-5 and of the Ohmeda Finapres 2300e which have been used in previous research (e.g., Beckham et al., 2002; Gregg, Matyas, & James, 2002; Philippsen et al., 2007; van Rooyen et al., 2004). The Finometer is based on the volume-clamp method first developed by Peňaz (1973). An appropriate-sized finger cuff is attached to the participant's middle finger which inflates to keep the arterial walls at a set diameter. In-built into this finger cuff is an infrared photo-plethysmograph which detects changes in the diameter of the arterial wall. When the intra-arterial pressure increases, thereby expanding the diameter of the arterial wall, a dynamic servo-controller immediately causes the finger cuff to inflate, thereby keeping the diameter of the artery at a constant position. When the volume clamp is active at the proper unloaded diameter, intra-arterial pressure equals that of the finger cuff pressure. Finometer uses Physiocal (Finapres Medical Systems, Amsterdam) to determine and maintain the pressure at which the finger artery is clamped (Wesseling, De Wit, Van der Hoeven, Van Goudoever, & Settels, 1995). Physiocal is an algorithm that establishes a setpoint level and provides for the periodic setpoint adjustment by a computer. This is necessary as changes in smooth muscle tone will lead to errors in blood pressure measurement if a fixed setpoint was used. The Physiocal criteria allows for correction of errors without interrupting continuous measurements (Wesseling et al., 1995). The Finometer has been shown to accurately assess absolute blood pressure in young participants (Schutte, Huisman, Van Rooyen, Oosthuizen, & Jerling, 2003) and in cardiac patients (Guelen et al., 2003). According to these studies, the validation criteria of the Association for the Advancement of Medical Instrumentation are satisfied by the Finometer.

In order to eliminate the impact of gender differences in cardiovascular function, especially in light of the small number of male participants recruited, Finometer measures were taken for female participants only (n = 105, or 78% of the sample).

Procedure

Each participant was met in the laboratory by the researcher and was asked to fill out a number of psychometric scales including the DS16, EPQ, HADS, and the PSS. Following completion of these scales, the Finometer cuff was applied to the participant’s finger and resting cardiovascular measures were taken over a 10-minute period. Reading material was supplied in order to facilitate genuine relaxation and the establishment of cardiovascular baselines (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992). Participants were fully debriefed following completion of data collection.

Data Analysis

Chi-squared analyses are conducted in order to test associations between nominal variables and to examine the overlap between the standard method of classification of Type D personality using the DS16 and the analogous method based on the EPQ (i.e., Type "E"). To confirm findings based on the chi-squared analyses, a logistic regression analysis examines if the categorical variable of Type D versus non-Type D as identified by the DS16 could be predicted by scores on the I and N scale of the EPQ. Effect sizes for chi-squared analyses (based on 2 × 2 contingency tables) are reported as phi (Φ). Construct and concurrent validity are established through examination of correlations among the subscales and examination of the internal consistency of the scales.

Stepwise regression is used to explore the relative contribution of Type D and Type "E" in predicting psychological and physiological outcomes. Continuous scores for Type D were produced by computing the product of NA and SI (NA × SI), while continuous scores for Type "E" were computed as the product of N and I (N × I). These products represent continuous analogues of the Type D and Type "E" personality distributions (see Whitehead et al., 2007). Main and interaction effects for Type D elements are assessed by entering individual scores for NA and SI, as well as NA × SI, in each model, while the corresponding effects for Type "E" are assessed by entering N, I, and N × I. Stepwise regression analyses were chosen over hierarchical regression in order to determine the relative strength of the two subscales and their interaction in predicting outcomes. So, NA, SI, and NA × SI were entered using stepwise methods and the strongest predictor(s) would emerge in the model, and likewise for the Type "E" traits. In order to confirm that Type D effects would be maintained when controlling for N and I, hierarchical multiple regression were used, with N and I entered in the first step and the NA × SI interaction term entered in the second. Effect sizes for multiple regressions are reported as percentage of variance in the criterion variable explained by the predictors, as identified by adjusted *R* squared.

Finally, in order to investigate categorical Type D and Type "E" associations with health outcomes, a series of independent *t*-tests were conducted. For the first series of independent *t*-tests, Type D was entered as the independent variable; for the second series of independent *t*-tests, Type "E" was entered as the independent variable.

Resting cardiovascular measures are examined as an objective index of well-being. In healthy populations, blood pressure is positively and linearly associated with lifetime rates of cardiovascular mortality (Fox et al., 2007; Prospective Studies Collaboration, 2002). Measures used in the present analyses are computed as the mean beat-to-beat readings obtained from minute 2 to minute 9 (inclusive) of the 10-minute measurement period.

Results

Personality Classification

Classification of Type D.

In line with current practice for the DS16, participants were classified as Type D and non-Type D based on a median split of the NA and SI subscales of the DS16. Median scores for NA and SI were observed to be 10 (range = [0, 25]) and 13 (range = [1, 28]), respectively, with no gender difference in the medians of either NA or SI (both *p*s > .05). Based on these medians, 40 participants (29.9% of the sample) were classified as Type D. The distribution of gender by Type D status not differing from chance levels ($p > .05$).

Classification of Type "E".

Correspondingly, participants were classified as Type "E" according to median splits of the N and I subscale scores from the EPQ. Median scores for N and I were observed to be 14 (range = [0, 24]) and 8 (range = [0, 20]), respectively. There were no gender differences in the median of either N or I. (both *p*s > .05). As a result, 37 participants (27.6% of the sample) were classified as Type "E", with the distribution of gender by Type "E" status not differing from chance levels ($p > .05$).

Overlap in Classifications

Independent *t*-tests revealed that all the items of the NA subscale of the DS16 differentiated between Type "E" and non-Type "E" individuals, while only half of the SI items did so. The SI items which did not differentiate Type "E" status were items 4 ("I have little impact on other people"), 5 ("I find it hard to express my opinions to others"), 7 ("I often find myself taking charge in group situations"), and 13 ("I like to be in charge of things"). Item 3 ("I often talk to strangers") had a *p* value of .04, deemed non-significant when applying a Bonferroni correction to control for Type I errors.

Chi-squared analyses were conducted to examine the overlap of classifications between the two methods. Perhaps unsurprisingly, a significant association between Type D and Type "E" status was observed, $\chi^2(1) = 34.72$, $p < .001$, $\Phi = .51$. To confirm these findings, a hierarchical logistic regression was conducted to examine if Type D classification as based on the DS16 could be predicted by scores on the N and I subscale of the EPQ. A test of the full model with all predictors against a constant only model was statistically reliable, $\chi^2(df = 2, N = 134) = 61.29$, $p < .001$, indicating that both N and I reliably predicted whether people would be classified as Type D using the DS16. The model correctly classified 83% of participants, and the variance in classification accounted for was good with a Cox & Snell $R^2 = .37$.

Validity of Type D and Type "E" Classifications

In order to examine the two methods of classification in more detail, a number of validity analyses were conducted. Construct validity of the two procedures was examined by conducting internal reliability analyses on the four subscales. Cronbach's α was used as a measure of internal reliability, with $\alpha = .70$ treated as the threshold of acceptability (Nunnally, 1978). Concurrent validity was assessed by examining targeted correlations among the sub-scales. Finally, discriminant validity was examined by using stepwise regression to identify the relative contribution of the two classification methods in accounting for variance in depression, anxiety, perceived stress, and cardiovascular measures.

Construct validity.

Cronbach's α for the NA and SI subscales of the DS16 was .88 and .79, respectively, and for the N and I subscales of the EPQ was .87 and .85. As such, all four subscales appeared to contain items that reliably identify common core variables, thereby implying construct validity.

Concurrent validity.

There were significant positive correlations between the NA and N, $r = +.73$, $p < .001$, and between SI and I, $r = +.64$, $p < .001$. To examine the correlations between the interaction terms, a Pearson's product moment correlation coefficient was conducted between NA × SI and N × I, and once again a positive correlation was observed, $r = +.69$, $p < .001$. Insofar as the interaction terms represent the Type D and Type "E" personalities, and insofar as it is predicted that the two overlap, the positive correlation confirms that both appear to be related to a common construct. All these correlations remained significant after applying Bonferroni correction.

Discriminant validity: Psychological criteria.

In order to compare the predictive power of Type D and Type “E” classifications in relation to psychological criterion variables, a series of multiple regressions using the stepwise method were conducted. Results are presented for each criterion in turn, namely, anxiety, depression, and perceived stress. In the first model in each section, the Type D components (NA, SI, and the interaction term NA × SI) are entered as predictors, while the second model contains the corresponding components for Type “E” (N, I, and N × I).

Anxiety. It was found that NA and SI (but not NA × SI) significantly predicted anxiety, $F(2,131) = 50.03$, $p < .001$, adjusted $R^2 = .42$. NA alone predicted 40% of the variance, with the addition of SI explaining a further 2% of the variance. In the second model, only N significantly predicted anxiety $F(1,132) = 145.17$, $p < .001$, adjusted $R^2 = .52$. Table 1 gives a summary of these regression models. It can be inferred that any association between either Type D or Type “E” and anxiety as measured by the HADS can be accounted for substantially by the NA or N components alone.

Depression (HADS). In the first model (Model 3, in Table 1), NA (but not SI or NA × SI) significantly predicted depression, $F(1,132) = 72.14$, $p < .001$, adjusted $R^2 = .35$. For the second model (Model 4, in Table 1), N and N × I (but not I) predicted depression, $F(2,131) = 36.59$, $p < .001$, adjusted $R^2 = .35$. N alone predicted 32.6% of the variance, with the addition of N × I explaining a further 2.3%. Table 1 indicates the relevant predictors of depression. Again it can be seen that any association between Type D or Type “E” and depression is likely to be substantially accounted for by the NA or N components.

Perceived Stress. Again, the first regression model revealed that NA (but not SI or NA × SI) significantly predicted perceived stress, $F(1,132) = 115.43$, $p < .001$, adjusted $R^2 = .46$, while the second model revealed the same effect for N (but not I or N × I), $F(1,132) = 117.58$, $p < .001$, adjusted $R^2 = .47$. Table 2 shows the significant predictors of perceived stress emerging from both analyses.

Insert Table 1 and Table 2 around here

Discriminant validity: Cardiovascular criteria

In order to examine the relative impact of the Type D and Type “E” on objective indices of well-being, a series of multiple regression analyses using the stepwise method were conducted on resting levels of SBP, DBP, HR, CO, and TPR. As reported above, cardiovascular measures were taken for the 105 female participants in the sample. A Kolmogorov-Smirnov test confirmed that the distributions for resting SBP, DBP, HR, and CO were each normal. For TPR a significant Kolmogorov-Smirnov test indicated a violation of the assumption of normality ($p < .001$), arising from which 9 outliers were removed. As such, analyses for TPR analysis were based on $n = 96$.

None of the Type D or Type “E” traits significantly predicted resting SBP, DBP, or HR. NA × SI showed some predictive power on resting measures of CO, $F(1, 103) = 5.33$, $p = .023$, adjusted $R^2 = .04$. None of the Type “E” traits predicted resting CO. For TPR, SI significantly predicting resting TPR, $F(1, 92) = 9.05$, $p = .003$, adjusted $R^2 = .08$, while I was also associated with elevated resting TPR, $F(1,92) = 11.89$, $p = .001$, adjusted $R^2 = .11$. Table 3 shows a summary of these regression models.

Insert Table 3 around here

To confirm that there is an association between the Type D continuous score and resting CO, when controlling for N and I, a hierarchical multiple regression was conducted with N and I entered in the first block, and NA × SI entered in the second. While the overall model was not significant, $F(3,101) = 1.94$, $p = .128$, meaning that N, I, and NA × SI as a set do not predict resting CO, the addition of NA × SI in the second step lead to a significant increase in the amount of variance in resting CO being accounted for, *F*change (1, 101) = 4.46, $p = .037$. As can be seen in Table 4, higher scores on NA × SI were associated with lower resting CO.

Insert Table 4 around here

Categorical Type D and health outcomes

A series of independent *t*-tests comparing Type D with non-Type D individuals showed that there were significant differences on anxiety, $t(57.14) = 3.73$, $p < .001$, depression, $t(53.57) = 4.95$, $p < .001$, and perceived stress, $t(132) = 4.81$, $p < .001$, with Type D individuals scoring higher on anxiety, depression, and perceived stress than non-Type D individuals. Likewise, there was a significant difference in resting CO, $F(103) = 2.28$, $p = .024$, and resting TPR, $F(92) = 2.39$, $p = .019$, with Type D individuals demonstrating lower resting CO but elevated TPR when compared to non-Type D individuals. Mean levels on each health outcome can be seen in Table 5.

For Type “E”, similar differences were evident on anxiety, $t(132) = 5.72$, $p < .001$, depression, $t(53.84) = 5.72$, $p < .001$, and perceived stress, $t(132) = 5.08$, $p < .001$, although there were no Type “E” differences on SBP, DBP, HR, CO, or TPR (all *p*s > .10).

Discussion

The present study provided preliminary evidence supporting the concurrent and construct validity of the Type D personality. Showing significant associations with the EPQ subscales, the findings suggest that the Type D personality is a valid construct within the present sample, indicating that the personality type could easily be assessed using mainstream personality measures, allowing a combination of scales method to be applied in existing research studies. Given the large correlations between the Type D scales with the relevant EPQ subscales, as well as equivalent associations with the health-related outcomes, these results support the idea that it is the latent variables behind what is known as the Type D personality that shows the relevant associations with health and not the specific scales.

Unsurprisingly, a significant overlap of classification between the two methods was observed, with similar numbers of participants identified as Type D regardless of whether the DS16 or EPQ were used. Although items of the DS16 differentiated between Type "E" and non-Type "E" status, the SI items did not show equal levels of discriminant ability. This indicates that the SI trait is not identical to the I trait and differs in some aspect. This has been suggested previously by Denollet (1998a) who suggested that the SI trait focuses on the interpersonal dimension of introversion (i.e., withdrawal and low self-expression; Asendorpf, 1993) rather than the intrapsychic (i.e., positive affect, energy, and excitement seeking; Watson, Clark, & Harkness, 1994) dimension.

The construct and concurrent validity of both the DS16 and the EPQ were established, suggesting that the items on these scales reliably identified common core variables. This not only suggests that the EPQ could be used as a proxy measure of the Type D personality (Kupper & Denollet, 2007), but rather, indicates that the Type D personality truly consists of two underlying core variables, which can validly be assessed using other psychometric instruments. This is important as existing research studies with measures of neuroticism and introversion already incorporated, could use these proxy measures for identification of the Type D personality in the absence of the specific Type D scales (Kupper & Denollet, 2007). Given the health-relevance of this particular personality type, this provides great scope to examine the influence of these personality traits on a range of health-related outcomes in both clinical and healthy populations.

It can be assumed that relationships between Type D or Type "E" personality and psychometrically-assessed anxiety, depression, and perceived stress were accounted for substantially by the NA or N components alone. This highlights the need for consideration of the role of neuroticism or NA when examining the link between Type D and psychometric measures of anxiety and depressive symptoms. Many studies have reported links between Type D and anxiety and depression (e.g., Pedersen, Ong et al., 2006; Schiffer, Pedersen, Broers, Widdershoven, & Denollet, 2008; van den Broek, Martens, Nyklíček, van der Voort, & Pedersen, 2007) but few have controlled for the possible effects of neuroticism. The present results suggest that, when psychometric instruments are used as outcome variables, NA may explain the reported effects of the Type D personality, rather than the synergistic effect of both NA and SI.

Examination of the objective indices of well-being indicated that while neither Type D nor Type “E” predicted resting blood pressure or HR measures, NA × SI predicted resting CO, while both SI and I predicted resting TPR. Specifically, NA × SI was associated with suppressed resting CO, while for TPR, both SI and I was associated with elevated resting levels. This falls in line with a recent study by Williams et al. (2009) who reported that Type D males exhibited increased CO during a cognitive stressor, while failing to show any relationship between the Type D personality and blood pressure, HR, or TPR measurements. In addition, recently, we have shown that the Type D personality shows a maladaptive pattern of cardiovascular responding on CO and TPR alone, in a sample of healthy individuals (Howard, Hughes, & James, 2011). Previous research has also shown that TPR recovery following an anger task is delayed in participants instructed to engage in emotional inhibition (Dorr, Brosschot, Sollers III, & Thayer, 2007). The inconsistent pattern of results on the cardiovascular variables within this study highlights that associations between the Type D personality and cardiovascular function may be seen at the underlying haemoydnamic determinant level (on examination of CO and TPR) rather than on blood pressure. In this respect, and given the fact that CO and TPR have a reciprocal relationship and therefore should be considered in tandem, future research could benefit from the examination of haemodynamic profile (see Gregg et al., 2002) when examining potential physiological mechanisms involved in Type D-health associations.

The findings of the present study may be limited by the healthy, largely female sample. Certainly, with respect to the cardiovascular variables, further research is necessary to establish the association between Type D personality and resting cardiovascular function. In addition, it may be the case that the Type D scales perform differently in cardiac and healthy samples, or indeed within male samples, on which much of the Type D epidemiological literature is based. However, using a healthy sample, free from cardiac or other diseases, offers a strength in that it allows examination of how this personality type is related to emotional health outcomes such as anxiety, depression, and stress without the potential confounds introduced with disease status. In addition, the use of an objective indicator of health status, cardiovascular function, offers a further strength as it allows examination of whether this personality type is associated with cardiac-related indices of health, before disease onset.

A further limitation of the present study is the use of the older DS16. Since 2004, a revised Type D scale is available; the DS14 (Denollet, 2005). Although both the DS16 and DS14 have shown good internal consistency, reliability, and validity, future research should focus on the DS14 when assessing the Type D traits, in order to provide comparable findings across studies.

Overall, the results of the present study suggests that the Type D personality is indeed an examination of two core factors of personality, identified within the Type D paradigm as NA and SI. Although NA and N can be considered synonymous, the relationship between SI and I is not as clear-cut, with the SI trait differing from I, in some discrete manner. Nevertheless, the present study supports the construct and concurrent validity of the Type D personality, as well suggesting it posses some discriminant validity with regard to cardiovascular function. What this adds to the literature is the confirmation that the Type D personality can be assessed using alternative psychometric measures rather than detracting from its significance in the health literature. This suggests that while the Type D personality may be considered “old wine in new bottles”, its value in the health literature is justified, and however it is assessed, the Type D personality shows strong associations with health-related outcomes, even in a healthy, non-clinical sample. These findings also suggest that existing research, using archival-prospective designs will allow the examination of this personality type in larger and more diverse samples, allowing confirmation that the Type D personality is a valid construct with significant influences on cardiovascular and emotional health.

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Table 1. Summary of stepwise regression models predicting anxiety and depression

	B	*SE B*	β	*t*	*p*	Adjusted R^2
Criterion: Anxiety						
Model 1 (Type D)						.42
NA	.48	.049	.715	9.85	<.001	
SI	-.13	.049	-.186	2.56	.012	
Excluded Variables						
NA × SI			-.078	.319	.750	
Model 2 (Type "E")						.52
N	.50	.042	.724	12.05	<.001	
Excluded Variables						
I			-.089	1.45	.151	
N × I			-.086	1.10	.272	
Criterion: Depression						
Model 3 (Type D)						.35
NA	.29	.034	.594	8.49	<.001	
Excluded Variables						
SI			.078	1.01	.316	
NA ×SI			.227	1.71	.089	
Model 4 (Type "E")						.36
N	.22	.046	.438	4.79	<.001	
N x I	.01	.003	.214	2.34	.021	
Excluded Variables						
I			-.194	1.027	.306	

Table 2. Summary of regression model predicting perceived stress

	B	*SE B*	β	*t*	*p*	Adjusted R^2
Criterion: Perceived Stress						
Model 1 (Type D)						.46
NA	.77	.071	.683	10.74	<.001	
Excluded Variables						
SI			-.056	.796	.427	
NA × SI			-.203	1.68	.095	
Model 2 (Type "E")						.47
N	.80	.073	.686	10.84	<.001	
Excluded Variables						
I			-.001	.016	.987	
N × I			-.018	.212	.832	

Table 3. Summary of stepwise regression models predicting resting cardiac output (CO) and total peripheral resistance (TPR)

	B	*SE B*	β	*t*	*p*	Adjusted R^2
Criterion: CO						
Model 1 (Type D)						.04
NA × SI	-.002	.001	-.222	2.309	.023	
Excluded Variables						
NA			.242	1.366	.175	
SI			.031	.196	.845	
Criterion: TPR						
Model 2 (Type D)						
SI	.009	.003	.299	3.008	.003	
Excluded Variables						
NA			.090	.824	.412	
NA × SI			.154	.955	.342	
Model 3 (Type "E")						
I	.012	.003	.338	3.449	.001	.11
Excluded Variables						
N			.021	.206	.837	
N × I			.026	.133	.894	

Table 4. Summary of hierarchical regression model predicting resting cardiac output

		B	*SE B*	β	*t*	*p*	Adjusted R^2
Block 1							.007
	Constant	6.33	.321		19.7	.000	
	N	-.012	.022	-.06	.56	.578	
	I	-.019	.024	-.08	.80	.427	
Block 2							.026
	Constant	6.121	.331		18.49	.000	
	N	.016	.025	.08	.65	.520	
	I	.012	.028	.05	.43	.669	
	NA × SI	-.003	.001	-.30	2.11	.037	

Table 5. Differences in health outcomes based on categorical Type D assessment

	Type D Status					
	Type D (*n* = 40)		Non-Type D (*n* = 94)			
	M	*SD*	*M*	*SD*	*t*	*p*
Anxiety (HADS)	9.50	4.34	6.67	3.14	3.73	<.001
Depression (HADS)	5.33	3.17	2.63	2.06	4.95	<.001
Perceived Stress (PSS)	20.85	5.39	15.59	5.97	4.81	<.001
*Resting SBP^{1}	122.44	24.62	123.14	15.95	.17	.865
*Resting DBP^{1}	71.92	13.54	71.76	9.85	.07	.947
*Resting HR^{2}	79.47	10.09	82.59	11.29	1.32	.191
*Resting CO^{3}	5.62	1.12	6.17	1.10	2.28	.024
**Resting TPR^{4}	.998	.17	.909	.16	2.30	.027

Notes. ^{1}mmHg, ^{2}bpm, ^{3}lpm, ^{4}pru,
**n* = 30 Type D; *n* = 30 non-Type D, ** *n* = 26 Type D; *n* = 68 non-Type D