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# The Androgen Receptor Gene and Psychological Traits: Are Results Consistent in Sweden and Australia?

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Studies in Sweden and Australia have examined the relationship between number of CAG repeats in the androgen receptor gene and psychological traits — three Masculinity-Femininity (M-F) measures in Australia, and the Karolinska Scales of Personality (KSP) in Sweden. The present study derived M-F scales from the KSP items, and scales corresponding to several KSP scales from the items of the inventories used in Australia, to permit cross-validation of the Australian results in the Swedish sample, and vice versa. The derivation of scales was facilitated by the fact that items from both inventories had been used with a large twin sample in the US. Correlation of the derived scales with androgen receptor gene CAG-repeat scores for women in the Australian and Swedish samples failed to provide clear evidence of replication of either set of original correlations in the other sample, although there were a few hints of consistency. It was concluded that if the number of CAG repeats on this gene is related to psychological traits at all, the relationship is a weak one.

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The X-linked androgen receptor (AR) gene may have varying numbers of repetitions of a particular CAG sequence. In normal samples, the number of repeats ranges from 11 to 31 (Edwards et al., 1992). Values of the repeat sequence lying above this range may be associated with various medical pathologies, such as spinal and bulbar muscular atrophy (MacLean et al., 1995). Short AR repeat lengths have been associated in several studies with a greater risk of prostate cancer in men (e.g., Giovannucci et al., 1997; Irvine et al., 1995). Small numbers of repeats have been linked to more effective transactivation of testosterone in vitro (Chamberlain et al., 1994).

Studies in Australia (Loehlin et al., 1999) and Sweden (Jönsson et al., 2001) examined the relationship between number of repeats on the AR gene and various psychological traits. In the Australian study, correlations were obtained between number of repeats and scores on three measures of masculinity-femininity (M-F) in a sample of 600 women (members of 300 monozygotic twin pairs). The three dimensions on which men and women differed had been derived in a large twin sample from the items of two

personality inventories, the Eysenck Personality Questionnaire (Eysenck et al., 1985), and the Cloninger Tridimensional Personality Questionnaire (Cloninger et al., 1991). These three derived M-F scales included a 12-item scale labelled Worried, in which women reported more worries and fears, on average, than did men; a 6-item scale labelled Reserved, in which men reported less willingness to express their feelings to others; and a 6-item scale labelled Breaks Rules, in which men reported more willingness to break or bend social rules. Of these scales, one, Reserved, showed a modest but statistically significant correlation of about  $-.13$  with number of AR repeats in the sample of 600 women. Another, Worried, showed a nonsignificant correlation of about  $.06$ . Both of these were in the expected direction of higher repeat scores going with more feminine traits. The third scale, Breaks Rules, showed no correlation with number of AR repeats.

The Swedish study (Jönsson et al., 2001) examined the relationship of the 15 scales of the Karolinska Scales of Personality (KSP; Schalling et al., 1987) to the number of AR repeats in two normal adult samples containing 154 women and 186 men from the Stockholm area. It found similarly low correlations (their absolute range was from  $.00$  to  $.19$ ), and concluded that in view of the number of scales examined and the sample sizes none of the relationships could confidently be regarded as established.

The present study attempts to cross-check these results in the opposite samples. Since the Karolinska scales had not been given to the Australian twins, and the Eysenck and Cloninger scales used in Australia were not given to the Swedish sample, such a comparison would necessarily be indirect. Nevertheless, there appeared to be considerable overlap in content between the two batteries, and it seemed worthwhile to attempt to derive scales from the items of the KSP that would measure the three masculinity-femininity dimensions, and scales from the Eysenck and Cloninger

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items that would measure at least some of the Karolinska dimensions (an initial inspection of items suggested that the content of a number of the Karolinska scales had little representation in the Eysenck and Cloninger item pools). This cross-matching effort was facilitated by the fact that a study in the US had administered six of the Karolinska scales as well as versions of the Eysenck and Cloninger questionnaires to a large sample of twins. The US sample was a volunteer sample originally ascertained for research on tobacco and alcohol use. Subjects were 4119 adult twins 50 to 96 years of age, 74% female, originally recruited between 1985 and 1989 through a newsletter published nationally by the American Association of Retired Persons. (For details, see Heath et al., 1993; and Stallings et al., 1999). These data, although based on a sample of elderly twins rather than the ordinary adult samples of the Swedish and Australian studies, would permit at least some direct empirical checks across the batteries.

The scales derived in this manner could then be correlated with the available AR scores in the genotyped Australian and Swedish samples to see if the Australian results on the M-F scales would be replicated among the Swedish women, and the correlations for at least some of the KSP scales confirmed in Australia.

## Method

### Constructing Three M-F scales from KSP Items

The six KSP scales which had been given in the US study — Somatic Anxiety, Psychic Anxiety, Muscular Tension, Impulsiveness, Monotony Avoidance, and Social Desirability — contained a number of items similar in content to items on the Worried scale, but relatively few that corresponded to the Reserved and Breaks Rules scales. There were a number of items elsewhere in the KSP, however, that appeared relevant to the latter two domains. Therefore, it was decided to proceed in a three-step manner: (1) to select a priori a core set of items from the KSP for each of the three M-F scales; (2) to correlate scores on these provisional scales in the Swedish sample with the remaining items of

the KSP; and (3) to refine the initial scales by adding additional items and deleting any items that failed to correlate with the others. Further checks on the derived scales were then carried out; for example, in the Swedish sample the means of the scales differed between men and women in the expected directions, and in the case of the Worried scale, for which a majority of the selected items were included in the KSP given in the US, a scale based on these KSP items correlated appropriately with the original scale from the Eysenck and Cloninger items.

In detail, the procedure was as follows. In the first step, items were selected from the KSP that appeared to be similar in content to the Eysenck and Cloninger items on the three original M-F scales. This proved to be easier for the Worried and Reserved scales than for Breaks Rules. For the former two, 12 and 10 items were chosen, respectively. For the latter, five items were chosen as a provisional scale — they appeared to be in the same general vicinity as the original Eysenck/Cloninger Breaks Rules items, but the correspondences were less close. The items in the initial core scales are listed in Table 1. These tentative scales were then scored for the individuals in the Swedish sample. Here and elsewhere, missing data were dealt with according to the following rule: If an individual responded to two-thirds or more of the items on a given scale, he or she was assigned a score based on the mean of the items completed; if more than a third of the items on a given scale were omitted, the individual was assigned a missing score on that scale.

Each of the three provisional scales was next correlated with the 135 items of the full KSP in the Swedish sample, separately for males and females. Items were identified that met two criteria: they were correlated significantly ( $p < .01$ ) with the provisional scale in both male and female samples, and they were not correlated more highly in either sample with either of the other two scales. Two additional candidate items were found for the Break Rules scale, and one for the Reserved scale, and these were added to the respective scales. They are shown at the end of the lists in Table 1, marked by an asterisk.

**Table 1**

KSP Versions of Three M-F Scales

Worried	Reserved	Breaks Rules
1. ill at ease	-12. easy to get close	(11. seldom remorseful)
-2. keen to try new	-25. want to confide	(47. shirkers feel guilt)
(8. spur of moment)	38. avoid prying people	-91. remorse at cheating
17. not self-confident	52. uneasy with confiders	117. played hooky often
36. sensitive	78. keep distance	122. have lied
74. long time to recover	92. avoid others' problems	*-16. never deliberately hurt
93. pressure at speed-up	105. hide my feelings	*98. gave trouble in school
97. worry re trifles	118. reserved vs. warm	
106. like time to act	119. on guard with people	
-120. calm and secure	-133. they tell me troubles	
121. worry re purchase	*-35. argument clears air	

Note: Minus sign means reversed in scoring.

\* items added.

items in parentheses deleted.

For the Worried scale, a large number of additional items passed the two criteria. Inspection of them suggested that most were items reflecting generally negative self-image (shyness, feelings of social inadequacy etc.) rather than matching the more specific content of the original Worried scale. Because the majority of the items had been given in the US sample, it was possible to compare two options empirically. Two scales were scored in the US sample, one based on the 8 of the core Worried KSP items that had been given to that sample, and one based on these plus the 20 additional available KSP items that had passed the screening criteria in the Swedish sample. These two scales were correlated with a scale based on the original Eysenck/Cloninger items. The 8-item scale correlated higher (.67 vs. .63) with the original scale, even despite its somewhat lower reliability (Cronbach alpha of .77 vs. .91). Thus it was decided to retain the original provisional scale for Worried rather than using an extended scale. Corrected for unreliability (scale reliabilities of .77 and .79), the observed correlation of .67 suggests an underlying correlation in the mid-.80s between the original and derived scales — not perfect, but presumably adequate to replicate an association with AR repeats, if such existed.

To increase their reliability, all three scales were then screened for any items that did not correlate at least .10 with a scale based on the rest of the items. One item was

dropped from the Worried scale, and two from Breaks Rules. Reserved did not require any deletions. The removed items are shown in parentheses in Table 1. Table 2 gives the male and female means and standard deviations in the Swedish samples for the final scales, as well as their reliabilities. The latter are presumably slightly inflated by chance in the item selection procedure, but with the sample sizes and the relatively small number of items involved in the changes, not much so, with the possible exception of Breaks Rules.

Except for Reserved, the sex differences in the Swedish sample tend to be somewhat smaller than the original ones in the Australian sample, where the effect sizes were  $-.61$ ,  $.50$  and  $.57$ , respectively. Whether this is a function of differences in the scales, or of differences in the Swedish and Australian populations, is not certain. Although the Australian samples were large, it is possible that there was some inflation of sex differences due to chance during the original scale derivation. On the other hand, it is also plausible that the Australian culture may place more emphasis on gender distinctions than the Swedish culture does. Nevertheless, it is clear that the direction of differences is replicated with the derived scales: Swedish women, like Australian women, worry more than men, express their feelings more freely to others, and break rules more reluctantly.

As a further check, effect sizes were obtained for the original M-F scales in the US sample. They were  $-.50$ ,  $.27$ , and  $.40$  for the Worried, Reserved, and Breaks Rules scales — similar in relative size to the Australian sample, and in absolute size to the Swedish sample. Thus the three M-F scales are consistent across these three samples and the differences in items, although the effect sizes vary somewhat.

The intercorrelations among the three scales also differ to some degree, as shown in Table 3. The three scales were derived to be essentially orthogonal within sexes in the Australian study; this status is confirmed among the US elderly. The KSP Worried and Reserved scales proved to be correlated positively in the Swedish sample. Breaks Rules remained reasonably independent of the other two. Either the KSP scales are not measuring exactly the same underlying variables as the original Eysenck/Cloninger scales, or these variables are differently aligned in the two samples. This would suggest some caution in interpreting the relationships

**Table 2**

KSP Versions of the Three M-F Scales in Swedish Sample:  
Means for Men and Women, Effect Sizes, and Scale Reliabilities

	Worried	Reserved	Breaks Rules
Mean, men	1.87	2.13	2.03
Mean, women	2.05	1.88	1.89
SD, men	0.48	0.43	0.49
SD, women	0.47	0.46	0.49
Effect size	$-0.38$	$0.54$	$0.28$
Reliability	0.86	0.80	0.52
Number of items	10	11	5

Note: A positive effect size indicates that men have the higher mean.  
Reliabilities are Cronbach alphas. *N*s are 203 men and 160 women.

**Table 3**

Within-sex Correlations Among M-F scales in Three Samples

	Worried- Reserved	Worried- Breaks Rules	Reserved- Breaks Rules	<i>N</i>
(E/C)				
Australian men	.06	$-.00$	$-.05$	2021–2025
Australian women	.05	$-.01$	$-.08$	3842–3846
(E/C)				
US men	.06	.02	$-.08$	1016–1018
US women	.01	.00	.03	2964–2974
(KSP)				
Swedish men	.30	.17	.17	202–203
Swedish women	.52	.12	.12	160

Note: E/C = M-F scales based on Eysenck and Cloninger items;  
KSP = derived M-F scales from Karolinska Scales of Personality items.

of the KSP-based scales to AR-gene repeats, but need not preclude examining these relationships. After all, the KSP scales do show the expected between-sex differences, and Worried performed well in a direct match.

#### Constructing KSP Scales from Eysenck/Cloninger Items

Six of the KSP scales had been administered along with the Eysenck and Cloninger scales to the US sample, and for these, items were selected directly to constitute provisional Eysenck/Cloninger versions of the scales. For two other KSP scales not given in the US, Detachment and Psychasthenia, the Eysenck/Cloninger item pool appeared to offer a reasonable number of candidate items, so items were selected by inspection to form provisional scales for these, as had been done with the M-F scales.

For the six KSP scales given in the US sample, Eysenck/Cloninger items were selected by the same criteria used earlier — significant correlations for both sexes and no larger correlations in either sex with any other scale. The selected items were limited to those available in the Australian sample, in which a short version of the Cloninger questionnaire had been used. One of the six KSP scales, Muscular Tension, selected only one Eysenck/Cloninger item, and was dropped from further consideration. The remaining five provisional Eysenck/Cloninger scales consisted of 6 items for Somatic Anxiety, 32 items for Psychic Anxiety, and 13 or 14 items for each of the other three — Impulsiveness, Monotony Avoidance, and Social Desirability.

As mentioned, in addition to these five scales, items were also selected a priori to constitute provisional Psychasthenia and Detachment scales. Eight items were chosen for each. The seven provisional scales were then correlated with the full set of Eysenck/Cloninger items in the Australian sample. The same criteria were used as in the derivation of the M-F scales in the Swedish sample: a significant correlation ( $p < .01$ ) in both male and female subsamples, and a higher correlation with the scale in question than with any of the other provisional scales, again for both sexes.

The results are given in Table 4. As in Table 1 the candidate items are listed along with items added or excluded at this step, as well as items dropped in a final step for having negative or near zero ( $r < .10$ ) correlations with a scale composed of the remaining items. In this last step, one item each was dropped from the Psychic Anxiety Social Desirability, and Detachment scales.

Table 5 shows the correlations among the seven scales separately for males and females. Again, there are both consistencies and differences. The Somatic Anxiety and Psychic Anxiety scales are positively correlated in all four samples, as are the Impulsiveness and Monotony Avoidance scales. These two clusters are roughly orthogonal, perhaps even slightly positively associated in their KSP versions, but there is a marked negative correlation (about  $-.5$ ) between the Psychic Anxiety and Monotony Avoidance scales in the Eysenck/Cloninger version.

There are also some differences in association of other scales with these two clusters. The Psychasthenia scale is close to the anxiety cluster in Sweden, whereas the Eysenck/Cloninger version is about midway between the

anxiety cluster and Monotony Avoidance (negative). The KSP version of Impulsiveness is fairly neutral with respect to Social Desirability in both Sweden and the US, whereas the Eysenck/Cloninger version is slightly negative ( $r$ s of about  $-.3$ ) with respect to Social Desirability in both the US and Australia. Finally, Detachment shows a stronger negative relationship to Monotony Avoidance in the Eysenck/Cloninger version than in the KSP version. It is mildly positively related to the anxiety scales across all samples — fairly strongly so for Swedish men.

Again, these moderate differences in orientation between the original and the Eysenck/Cloninger versions of the KSP scales suggest some caution is appropriate when interpreting their correlations with AR-gene repeats. The differences do not appear to be so great, however, as to make such comparisons meaningless.

Table 6 shows correlations in the US sample between the final Eysenck/Cloninger versions of the KSP scales and the KSP scales themselves. The bold-faced correlations in the diagonal show that the corresponding scales tend to correlate in the mid .50s, except for Social Desirability, which is lower, at .34, and Psychic Anxiety, which is higher, at .68. With scale reliabilities mostly in the .60s and .70s, these are reasonably high correlations. The fact of positive correlations is, of course, not surprising, since the initial selection of the Eysenck/Cloninger items corresponding to the KSP scales was made using this sample. Nevertheless, the correlations show that the steps of combining the items into scales and refining these scales in the Australian sample has resulted in scales still substantially correlated with their KSP equivalents.

Also evident in the off-diagonal correlations in the table are the clustering of the two anxiety scales and of Impulsiveness and Monotony Avoidance, as well as the negative association between the timidity of Psychic Anxiety and the thrill-seeking of Monotony Avoidance.

## Results

Because the AR repeat scores were only available for women in the Australian sample, the primary evidence of replication will be for the female samples in both cases. The AR score used was the mean CAG sequence length for the woman's two X chromosomes. Table 7 shows the results for the M-F scales.

There is at best only weak evidence of replication here. In both studies, the correlations, except for those that are essentially zero, do tend to lie in the appropriate direction of more masculine scores going with fewer CAG repeats, but they are very small. Moreover, the particular subscales differ. The Reserved dimension, for which the evidence in the Australian sample was strongest, is correlated essentially zero for Swedish women. Breaks Rules, which was not correlated at all with M-F in Australia, shows a correlation in the theoretically appropriate direction in Sweden (higher scores go with shorter repeat sequences), but samples of 1000 or so would be required for a correlation of this size to be statistically dependable. Only the Worried scale offers any sign of replication, with small correlations in both samples in the theoretically appropriate direction (more worried, longer repeat sequences). It seems clear that the

**Table 4**

Eysenck/Cloninger Versions of Seven KSP Scales

<b>Somatic Anxiety (.79)</b>			
e1. mood up and down e49. often lonely *e25. often feel guilt -e43. like mixing	e6. just miserable c8. get worried *e26. nervous person	e24. fed-up *e12. irritable *e33. highly-strung	e47. nerves *e13. like to be feared *e53. bad temper
<b>Psychic Anxiety (.88)</b>			
e2. care what they think -e15. enjoy new people e28. worrier -e43. like mixing c5. worried c11. worried unfamiliar c23. avoid soc. sit. -c46. get over it quickly *-e56. happy-go-lucky	e5. debt would worry e20. hurt feelings -e32. social initiative e46. worry long -c6. carefree c13. worried unfamiliar -c27. relaxed strangers (c49. don't open up)	-e7. rather lively e21. keep in background e35. mistakes worry -e51. lively (c7. don't tell thoughts) c19. shy with strangers (c28. could do more) -c50. sure of myself	-e11. let go at party (e25. often feel guilt) e41. quiet in public -c1. confident c10. tense at new c22. avoid strangers (c42. find change hard) (c51. cool and detached)
<b>Social Desirability (.74)</b>			
e4. keep promises -e23. taken something -e39. cheeky to parents c20. moved by appeals *-e31. lost other's item	-e9. ever greedy -e27. taken advantage -e52. ever cheated c38. can't tell a lie *-e55. put off something	-e14. take strange drug (e34. enjoy cooperating) e54. practice preach *-e16. blamed innocent *c52. like to please	e18. good habits -e36. said nasty thing c17. sympathetic *e22. manners matter
<b>Impulsiveness (.76)</b>			
-e10. stop to think (e56. happy-go-lucky) c30. follow instincts c40. get in debt *c41. spend on impulse	e19. act rashly c12. act in the moment -c33. all the details *e17. dislike rules *-c44. hate decide fast	e29. spur of moment c14. often break rules -c34. always details *-e48. follow rules	e37. anti-insurance -c21. very practical -c39. good at saving *-c29. think a long time
<b>Monotony Avoidance (.66)</b>			
e38. take on too much c2. fun or thrills -c31. satisfied -c48. enjoy saving	e42. liven dull party (c3. discuss feelings) c36. stretch the truth -c53. like stay home	-(e44. act quickly) c4. look for thrills c45. moved by poetry *e45. get party going	e50. like excitement -c25. slow to new ideas (c47. hide problems)
<b>Psychasthenia (.66)</b>			
e44. like decide fast -c43. energetic *-c26. push self hard	-c9. do things my way -c54. determined *c28. just get by	c32. tire quickly *-c16. calm in danger	-c37. on the go all day *-c24. push myself
<b>Detachment (.71)</b>			
-c3. discuss feelings c47. hide problems *c35. don't try to please	c7. don't tell thoughts c49. don't open up	c18. reserved c51. cool and detached	(-c20. moved by appeals) *-e3. talkative

Note: Minus sign means item reversed in scoring.

\* items added.

items in parentheses deleted.

Reliability (Cronbach's alpha) shown after title of scale.

**Table 5**  
Intercorrelations of 7 KSP Scales for Women (Above Diagonal) and Men (Below Diagonal), in Three Samples

	SA	PA	SD	IM	MA	PT	DT
KSP, Swedish sample							
SA	1.00	.74	-.25	.22	.12	.65	.19
PA	.59	1.00	-.28	-.00	.06	.71	.30
SD	-.25	-.20	1.00	-.15	-.07	-.41	-.20
IM	.05	-.17	-.02	1.00	.37	.06	.01
MA	.10	-.15	-.05	.54	1.00	-.04	-.15
PT	.63	.60	-.17	-.15	-.10	1.00	.25
DT	.40	.56	-.21	-.20	-.27	.33	1.00
KSP, US sample							
SA	1.00	.67	-.06	.22	.12		
PA	.69	1.00	.01	.12	-.02		
SD	-.20	-.11	1.00	-.03	-.06		
IM	.26	.17	-.03	1.00	.37		
MA	.14	.05	-.02	.40	1.00		
Eysenck/Cloninger, US sample							
SA	1.00	.47	-.15	.15	-.07	.11	.07
PA	.45	1.00	-.04	-.12	-.50	.30	.36
SD	-.17	-.10	1.00	-.27	-.12	-.06	.09
IM	.20	-.10	-.29	1.00	.27	-.06	-.18
MA	-.06	-.48	-.05	.28	1.00	-.35	-.49
PT	.09	.30	-.09	-.05	-.35	1.00	.05
DT	.04	.39	-.01	-.15	-.51	.03	1.00
Eysenck/Cloninger, Australian sample							
SA	1.00	.51	-.14	.21	-.04	.13	.06
PA	.51	1.00	.00	-.15	-.50	.34	.39
SD	-.16	-.03	1.00	-.31	-.17	-.11	.12
IM	.19	-.18	-.33	1.00	.36	-.10	-.18
MA	-.05	-.52	-.14	.38	1.00	-.35	-.41
PT	.10	.34	-.14	-.12	-.37	1.00	.00
DT	.07	.37	.03	-.16	-.38	.02	1.00

Note: SA = somatic anxiety, PA = psychic anxiety, SD = social desirability, IM=impulsiveness, MA = monotony avoidance, PT = psychasthenia, DT = detachment

**Table 6**  
Correlations Between Final Eysenck/Cloninger Scales and KSP Scales in the US Sample (Sexes Combined)

KSP scale	Eysenck/Cloninger scale						
	SA	PA	SD	IM	MA	PT	DT
Somatic Anxiety	<b>.54</b>	.44	-.07	.13	-.09	.17	.10
Psychic Anxiety	.51	<b>.68</b>	-.02	.02	-.24	.20	.22
Social Desirability	-.08	-.08	<b>.34</b>	-.16	.01	-.09	-.01
Impulsiveness	.10	-.13	-.16	<b>.54</b>	.24	-.08	-.14
Monotony Avoidance	.03	-.26	-.11	.28	<b>.55</b>	-.26	-.19

Note: SA = somatic anxiety, PA = psychic anxiety, SD = social desirability, IM = impulsiveness, MA = monotony avoidance, PT = psychasthenia, DT = detachment. *N*s 3833–3923. Bold type indicates correlations between matching scales.

**Table 7**  
Correlations of Three M-F Scales with AR-gene Repeat Scores for Swedish and Australian Women

Scale	Sweden	Australia
Worried	.10	.06
Reserved	.02	-.13
Breaks Rules	-.06	.00
<i>N</i>	160	557–560

Note: Australian women from 300 MZ twin pairs; data from Loehlin et al. (1999)

**Table 8**

Correlations of Seven KSP Scales with AR-gene Repeat Scores for Australian and Swedish Women

Scale	Australia	Sweden
Somatic Anxiety	.06	.12
Psychic Anxiety	.04	.04
Social Desirability	-.04	.06
Impulsiveness	.04	.13
Monotony Avoidance	-.01	.08
Psychasthenia	.02	.15
Detachment	-.07	.02
<i>N</i>	557–560	150–152

Note: Australian women from 300 MZ twin pairs.  
Swedish data from Jönsson et al. (2001)

relationship between the number of AR-gene repeats and psychological femininity, if it exists at all, must be a very weak one.

What about the KSP scales and AR-gene repeats? Table 8 presents the correlations of AR-gene CAG repeats with the Eysenck/Cloninger versions of the seven KSP scales, for Australian women. For comparison, correlations with the original KSP scales for Swedish women obtained by Jönsson et al. (2001) are also given. Those authors' caution in drawing any positive conclusion appears to be thoroughly justified. It is evident that the Australian correlations are such that they could be chance deviations from a population correlation of zero. Their range is from  $-.07$  to  $+.06$ ; three are negative and four are positive. Five of the seven fall within one standard error of zero:  $.042$  for a sample of this size.

A comparison of scale ordering in the two samples suggests at most some slight consistency. For example, Somatic Anxiety is one of the scales most positively correlated with AR repeats in both samples, and Detachment falls at the opposite extreme. The Spearman rank correlation between the two sets of correlations is  $+.51$ : appreciable, but well short of conventional levels of statistical significance, given only seven scales.

The above analyses were done using mean sequence length. To allow for the possibility of dominance effects, correlations were also done using only the longer or only the shorter of the woman's two CAG sequences. This did not make a consistent difference. The M-F scale correlations were replicated slightly better using the shorter of the two sequences; the KSP scales using the longer. None of the differences were large.

## Discussion

The simplest conclusion from this effort at cross-validation is that the number of CAG repeats on the AR gene is related essentially at chance levels with Masculinity-Femininity or other personality traits in women. At best, if they are related at all, the relationship is very weak.

If a weak relationship does exist, very large sample sizes would be required to detect it dependably, and even larger ones to make useful discriminations across traits. Obviously,

we would still be a long way from making meaningful predictions for individuals.

An alternative interpretation of our results might be that the creation of matching scales across the two questionnaires was so problematic that no conclusions whatsoever should be drawn from a lack of replication across studies. We do not believe this to be the case. Where tests of the matching were available, as in the appropriate sex differences for the M-F scales in the Swedish sample, or in the correlation between putatively equivalent scales in the US sample, there was evidence of reasonable agreement (as well as evidence that it was less than perfect). Alternatively, one might wonder if the Swedish and Australian populations are comparable. Again, consistency of the sex differences and agreements with the US sample would suggest that they are sufficiently so to make the comparisons meaningful.

There are, of course, excellent reasons for supposing that the relationship of a genetic variable like AR repeats with a psychological trait in normal adults, if such a relationship exists at all, should be represented by only a small correlation. It is commonly assumed that many genes as well as numerous environmental factors affect the development of human psychological traits, so that the effect of any one of these in accounting for individual differences on the trait is likely to be small.

An optimist who prefers to view a glass as 5% full rather than 95% empty might draw some comfort from the modest hints of consistency appearing in these data. The evidence suggests, however, that he or she would be well advised, if pursuing such hints further, to plan on using very large samples.

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