CASCADE MODEL: ALGEBRA

version 11/28/2007

$\sigma_{\bullet}^2$: phenotypic variance
$\tau_{\bullet}^2$: covariance between the true phenotype and the phenotype on which mates assort
$\delta_{\bullet}$: covariance between additive genetic latent factor and phenotype
$\pi_{\bullet}$: covariance between male-specific additive genetic latent factor and phenotype

d : copath between spouses; note that $r(spouse) = d\tau_m \tau_f$

$a_{\bullet}$: additive genetic path
$b_{\bullet}$: male-specific additive genetic path
$d_{\bullet}$: dominance genetic path
$s_{\bullet}$: sibling-specific environmental path
$t_{\bullet}$: twin-specific environmental path
$e_{\bullet}$: unique environmental path
$f_{\bullet}$: familial path – set to 1

$x_{\bullet}$: variance of familial environment
q : variance of common additive genetic latent factor
y : variance of male-specific additive genetic latent factors

$w_{\bullet}$: covariance between additive genetic latent factor and familial latent factor
$v_{\bullet}$: covariance between male-specific additive genetic latent factor and familial latent factor
r : covariance between male-specific and common additive genetic latent factors

z_d : correlation between the dominance latent factors between opposite sex sibs/twins
z_t : correlation between the twin latent factors between opposite sex sibs/twins
z_s : correlation between the sibling latent factors between opposite sex sibs/twins

Subscripts. *m* male; *f* female; • male *or* female; *MZ1* monozygotic twin 1; *DZ1* dizygotic twin 1; *T1* monozygotic *or* dizygotic twin 1.
Superscripts. ~ pathways to the latent factor on which spouses mate assortatively

Constraints

<u>Within-person or MZ-related constraints</u>

1. $CV(A_m, P_m) = CV(A_{MZM1}, P_{MZM2}) = \delta_m = q(a_m) + r(b_m) + w_m$
2. $CV(A_m, \tilde{P}_m) = CV(A_{MZM1}, \tilde{P}_{MZM2}) = \tilde{\delta}_m = q(\tilde{a}_m) + r(\tilde{b}_m) + w_m(\tilde{f}_m)$
3. $CV(A_f, P_f) = CV(A_{MZF1}, P_{MZF2}) = \delta_f = q(a_f) + r(b_f) + w_f$
4. $CV(A_f, \tilde{P}_f) = CV(A_{MZF1}, \tilde{P}_{MZF2}) = \tilde{\delta}_f = q(\tilde{a}_f) + r(\tilde{b}_f) + w_f(\tilde{f}_f)$

5. $CV(B_m, P_m) = CV(B_{MZM1}, P_{MZM2}) = \pi_m = y(b_m) + r(a_m) + v_m$
6. $CV(B_m, \tilde{P}_m) = CV(B_{MZM1}, \tilde{P}_{MZM2}) = \tilde{\pi}_m = y(\tilde{b}_m) + r(\tilde{a}_m) + v_m(\tilde{f}_m)$
7. $CV(B_f, P_f) = CV(B_{MZF1}, P_{MZF2}) = \pi_f = y(b_f) + r(a_f) + v_f$
8. $CV(B_f, \tilde{P}_f) = CV(B_{MZF1}, \tilde{P}_{MZF2}) = \tilde{\pi}_f = y(\tilde{b}_f) + r(\tilde{a}_f) + v_f(\tilde{f}_f)$

<u>Variance or covariance-related constraints</u>

9. $q = CV(A_{MZ1}, A_{MZ2}) = .5q + .5 + .5\tilde{\delta}_m d\tilde{\delta}_f$
   $q = 1 + \tilde{\delta}_m d\tilde{\delta}_f$
10. $y = CV(B_{MZ1}, B_{MZ2}) = .5y + .5 + .5\tilde{\pi}_m d\tilde{\pi}_f$
   $y = 1 + \tilde{\pi}_m d\tilde{\pi}_f$

11. $x_m = CV(F_{T1,m}, F_{T2,m}) = m^2\sigma_m^2 + o^2\sigma_f^2 + 2mo(\tau_m^2 d\tau_f^2)$
12. $x_f = CV(F_{T1,f}, F_{T2,f}) = n^2\sigma_m^2 + p^2\sigma_f^2 + 2np(\tau_m^2 d\tau_f^2)$
13. $x_{mf} = CV(F_{T1,m}, F_{T2,f}) = mn\sigma_m^2 + op\sigma_f^2 + mp(\tau_m^2 d\tau_f^2) + no(\tau_m^2 d\tau_f^2)$

14. $CV(A, B) = CV(A_{T1}, B_{T2}) = r = .5r + .25d(\tilde{\delta}_m\tilde{\pi}_f + \tilde{\delta}_f\tilde{\pi}_m)$
   $r = .5d(\tilde{\delta}_m\tilde{\pi}_f + \tilde{\delta}_f\tilde{\pi}_m)$

15. $CV(A, F_m) = CV(A_{T1}, F_{T2m}) = w_m = .5\delta_m m + .5\delta_f o + .5\tilde{\delta}_m d\tau_f^2 o + .5\tilde{\delta}_f d\tau_m^2 m$
16. $CV(A, F_f) = CV(A_{T1}, F_{T2f}) = w_f = .5\delta_f p + .5\delta_m n + .5\tilde{\delta}_f d\tau_m^2 n + .5\tilde{\delta}_m d\tau_f^2 p$

17. $CV(B, F_m) = CV(B_{T1}, F_{T2m}) = v_m = .5\pi_m m + .5\pi_f o + .5\tilde{\pi}_m d\tau_f^2 o + .5\tilde{\pi}_f d\tau_m^2 m$
18. $CV(B, F_f) = CV(B_{T1}, F_{T2f}) = v_f = .5\pi_f p + .5\pi_m n + .5\tilde{\pi}_f d\tau_m^2 n + .5\tilde{\pi}_m d\tau_f^2 p$

19. $\sigma_m^2 = a_m^2(q) + b_m^2(y) + x_m + 2a_m b_m r + 2a_m w_m + 2b_m v_m + d_m^2 + s_m^2 + t_m^2 + e_m^2$
20. $CV(P_m, \tilde{P}_m) = \tau_m^2 = a_m\tilde{a}_m(q) + b_m\tilde{b}_m(y) + \tilde{f}_m(x_m) + \tilde{a}_m b_m r + a_m\tilde{b}_m r + \tilde{a}_m w_m + a_m\tilde{f}_m w_m + \tilde{b}_m v_m + b_m\tilde{f}_m v_m$
   $+ d_m\tilde{d}_m + s_m\tilde{s}_m + t_m\tilde{t}_m + e_m\tilde{e}_m$

21. $\sigma_f^2 = a_f^2(q) + b_f^2(y) + x_f + 2a_f b_f r + 2a_f w_f + 2b_f v_f + d_f^2 + s_f^2 + t_f^2 + e_f^2$
22. $CV(P_f, \tilde{P}_f) = \tau_f^2 = a_f\tilde{a}_f(q) + b_f\tilde{b}_f(y) + \tilde{f}_f(x_f) + \tilde{a}_f b_f r + a_f\tilde{b}_f r + \tilde{a}_f w_f + a_f\tilde{f}_f w_f + \tilde{b}_f v_f + b_f\tilde{f}_f v_f$
   $+ d_f\tilde{d}_f + s_f\tilde{s}_f + t_f\tilde{t}_f + e_f\tilde{e}_f$

<u>Twin/Sibling-related constraints</u>

23. $CV(A_{DZ1}, A_{DZ2}) = .5q + .5(\tilde{\delta}_f d\tilde{\delta}_m) = q - .5$

24. $CV(A_{DZ1,\bullet}, P_{DZ2,m}) = \theta_{\bullet m} = .5a_m(q) + .5a_m(\tilde{\delta}_f d\tilde{\delta}_m) + .5rb_m + .25db_m(\tilde{\delta}_m\tilde{\pi}_f + \tilde{\delta}_f\tilde{\pi}_m) + w_m$
   $\theta_{\bullet m} = a_m(q - .5) + b_m r + w_m$
25. $CV(A_{DZ1,\bullet}, P_{DZ2,f}) = \theta_{\bullet f} = .5a_f(q) + .5a_f(\tilde{\delta}_m d\tilde{\delta}_f) + .5rb_f + .25db_f(\tilde{\delta}_m\tilde{\pi}_f + \tilde{\delta}_f\tilde{\pi}_m) + w_f$
   $\theta_{\bullet f} = a_f(q - .5) + b_f r + w_f$

26. $CV(A_{DZ1,\bullet},\tilde{P}_{DZ2,m}) = \tilde{\theta}_{\bullet m} = \tilde{a}_m(q-.5) + \tilde{b}_m r + \tilde{f}_m w_m$
27. $CV(A_{DZ1,\bullet},\tilde{P}_{DZ2,f}) = \tilde{\theta}_{\bullet f} = \tilde{a}_f(q-.5) + \tilde{b}_f r + \tilde{f}_f w_f$

28. $CV(B_{DZ1},B_{DZ2}) = .5y + .5(\tilde{\pi}_f d\tilde{\pi}_m) = y - .5$

29. $CV(B_{DZ1,\bullet},P_{DZ2,m}) = \varphi_{\bullet m} = .5b_m(y) + .5b_m(\tilde{\pi}_f d\tilde{\pi}_m) + .5ra_m + .25da_m(\tilde{\delta}_m\tilde{\pi}_f + \tilde{\delta}_f\tilde{\pi}_m) + v_m$
$\varphi_{\bullet m} = b_m(y-.5) + a_m r + v_m$
30. $CV(B_{DZ1,\bullet},P_{DZ2,f}) = \varphi_{\bullet f} = .5b_f(y) + .5b_f(\tilde{\pi}_m d\tilde{\pi}_f) + .5ra_f + .25da_f(\tilde{\delta}_m\tilde{\pi}_f + \tilde{\delta}_f\tilde{\pi}_m) + v_f$
$\varphi_{\bullet f} = b_f(y-.5) + a_f r + v_f$

31. $CV(B_{DZ1,\bullet},\tilde{P}_{DZ2,m}) = \tilde{\varphi}_{\bullet m} = \tilde{b}_m(y-.5) + \tilde{a}_m r + \tilde{f}_m v_m$
32. $CV(B_{DZ1,\bullet},\tilde{P}_{DZ2,f}) = \tilde{\varphi}_{\bullet f} = \tilde{b}_f(y-.5) + \tilde{a}_f r + \tilde{f}_f v_f$

<u>Avuncular-related constraints</u>
33. $CV(A_{MZ1},P_{MZM\,2.son}) = \xi_{\bullet Mm} = .5a_m(q+\tilde{\delta}_m d\tilde{\delta}_f) + .5b_m(r+\tilde{\pi}_f d\tilde{\delta}_m) + \delta_m m + o\tau_f^2 d\tilde{\delta}_m$
34. $CV(A_{MZ1},P_{MZF\,2.son}) = \xi_{\bullet Fm} = .5a_m(q+\tilde{\delta}_m d\tilde{\delta}_f) + .5b_m(r+\tilde{\pi}_m d\tilde{\delta}_f) + \delta_f o + m\tau_m^2 d\tilde{\delta}_f$
35. $CV(A_{MZ1},P_{MZM\,2.dau}) = \xi_{\bullet Mf} = .5a_f(q+\tilde{\delta}_m d\tilde{\delta}_f) + .5b_f(r+\tilde{\pi}_f d\tilde{\delta}_m) + \delta_m n + p\tau_f^2 d\tilde{\delta}_m$
36. $CV(A_{MZ1},P_{MZF\,2.dau}) = \xi_{\bullet Ff} = .5a_f(q+\tilde{\delta}_m d\tilde{\delta}_f) + .5b_f(r+\tilde{\pi}_m d\tilde{\delta}_f) + \delta_f p + n\tau_m^2 d\tilde{\delta}_f$

37. $CV(A_{DZ1},P_{DZM\,2.son}) = \lambda_{\bullet Mm} = .5a_m((q-.5)+\tilde{\delta}_f d\tilde{\theta}_{\bullet m}) + .5b_m(r+\tilde{\pi}_f d\tilde{\theta}_{\bullet m}) + \theta_{\bullet m} m + o\tau_f^2 d\tilde{\theta}_m$
38. $CV(A_{DZ1},P_{DZF\,2.son}) = \lambda_{\bullet Fm} = .5a_m((q-.5)+\tilde{\delta}_m d\tilde{\theta}_{\bullet f}) + .5b_m(r+\tilde{\pi}_m d\tilde{\theta}_{\bullet f}) + \theta_{\bullet f} o + m\tau_m^2 d\tilde{\theta}_f$
39. $CV(A_{DZ1},P_{DZM\,2.dau}) = \lambda_{\bullet Mf} = .5a_f((q-.5)+\tilde{\delta}_f d\tilde{\theta}_{\bullet m}) + .5b_f(r+\tilde{\pi}_f d\tilde{\theta}_{\bullet m}) + \theta_{\bullet m} n + p\tau_f^2 d\tilde{\theta}_m$
40. $CV(A_{DZ1},P_{DZF\,2.dau}) = \lambda_{\bullet Ff} = .5a_f((q-.5)+\tilde{\delta}_m d\tilde{\theta}_{\bullet f}) + .5b_f(r+\tilde{\pi}_m d\tilde{\theta}_{\bullet f}) + \theta_{\bullet f} p + n\tau_m^2 d\tilde{\theta}_f$

41. $CV(B_{MZ1},P_{MZM\,2.son}) = \alpha_{\bullet Mm} = .5b_m(y+\tilde{\pi}_m d\tilde{\pi}_f) + .5a_m(r+\tilde{\delta}_f d\tilde{\pi}_m) + \pi_m m + o\tau_f^2 d\tilde{\pi}_m$
42. $CV(B_{MZ1},P_{MZF\,2.son}) = \alpha_{\bullet Fm} = .5b_m(y+\tilde{\pi}_m d\tilde{\pi}_f) + .5a_m(r+\tilde{\delta}_m d\tilde{\pi}_f) + \pi_f o + m\tau_m^2 d\tilde{\pi}_f$
43. $CV(B_{MZ1},P_{MZM\,2.dau}) = \alpha_{\bullet Mf} = .5b_f(y+\tilde{\pi}_m d\tilde{\pi}_f) + .5a_f(r+\tilde{\delta}_f d\tilde{\pi}_m) + \pi_m n + p\tau_f^2 d\tilde{\pi}_m$
44. $CV(B_{MZ1},P_{MZF\,2.dau}) = \alpha_{\bullet Ff} = .5b_f(y+\tilde{\pi}_m d\tilde{\pi}_f) + .5a_f(r+\tilde{\delta}_m d\tilde{\pi}_f) + \pi_f p + n\tau_m^2 d\tilde{\pi}_f$

45. $CV(B_{DZ1},P_{DZM\,2.son}) = \beta_{\bullet Mm} = .5b_m((y-.5)+\tilde{\pi}_f d\tilde{\varphi}_m) + .5a_m(r+\tilde{\delta}_f d\tilde{\varphi}_m) + \varphi_{\bullet m} m + o\tau_f^2 d\tilde{\varphi}_m$
46. $CV(B_{DZ1},P_{DZF\,2.son}) = \beta_{\bullet Fm} = .5b_m((y-.5)+\tilde{\pi}_m d\tilde{\varphi}_f) + .5a_m(r+\tilde{\delta}_m d\tilde{\varphi}_f) + \varphi_{\bullet f} o + m\tau_m^2 d\tilde{\varphi}_f$
47. $CV(B_{DZ1},P_{DZM\,2.dau}) = \beta_{\bullet Mf} = .5b_f((y-.5)+\tilde{\pi}_f d\tilde{\varphi}_m) + .5a_f(r+\tilde{\delta}_f d\tilde{\varphi}_m) + \varphi_{\bullet m} n + p\tau_f^2 d\tilde{\varphi}_m$
48. $CV(B_{DZ1},P_{DZF\,2.dau}) = \beta_{\bullet Ff} = .5b_f((y-.5)+\tilde{\pi}_m d\tilde{\varphi}_f) + .5a_f(r+\tilde{\delta}_m d\tilde{\varphi}_f) + \varphi_{\bullet f} p + n\tau_m^2 d\tilde{\varphi}_f$

Relative Covariances

<u>MZ Twins:</u> $P-P$
1. $CV(MZM,MZM) = \Phi_{mm} = a_m^2(q) + b_m^2(y) + x_m + 2a_m b_m r + 2a_m w_m + 2b_m v_m + d_m^2 + t_m^2 + s_m^2$
2. $CV(MZF,MZF) = \Phi_{ff} = a_f^2(q) + b_f^2(y) + x_f + 2a_f b_f r + 2a_f w_f + 2b_f v_f + d_f^2 + t_f^2 + s_f^2$

<u>MZ Twins:</u> $P-\widetilde{P}$

$$CV(P_{MZ1,m},\widetilde{P}_{MZ2,m})=\widetilde{\Phi}_{mm}=a_m\widetilde{a}_m(q)+b_m\widetilde{b}_m(y)+\widetilde{f}_m(x_m)+\widetilde{a}_m b_m r+a_m\widetilde{b}_m r+\widetilde{a}_m w_m+a_m\widetilde{f}_m w_m+\widetilde{b}_m v_m+b_m\widetilde{f}_m v_m$$
$$+d_m\widetilde{d}_m+s_m\widetilde{s}_m+t_m\widetilde{t}_m$$

$$CV(P_{MZ1.f},\widetilde{P}_{MZ2.f})=\widetilde{\Phi}_{ff}=a_f\widetilde{a}_f(q)+b_f\widetilde{b}_f(y)+\widetilde{f}_f(x_f)+\widetilde{a}_f b_f r+a_f\widetilde{b}_f r+\widetilde{a}_f w_f+a_f\widetilde{f}_f w_f+\widetilde{b}_f v_f+b_f\widetilde{f}_f v_f$$
$$+d_f\widetilde{d}_f+s_f\widetilde{s}_f+t_f\widetilde{t}_f$$

<u>MZ Twins:</u> $\widetilde{P}-\widetilde{P}$

$$CV(\widetilde{P}_{MZ1,m},\widetilde{P}_{MZ2,m})=\widetilde{\widetilde{\Phi}}_{mm}=\widetilde{a}_m^2(q)+\widetilde{b}_m^2(y)+\widetilde{f}_m^2x_m+2\widetilde{a}_m\widetilde{b}_m r+2\widetilde{a}_m\widetilde{f}_m w_m+2\widetilde{b}_m\widetilde{f}_m v_m+\widetilde{d}_m^2+\widetilde{t}_m^2+\widetilde{s}_m^2$$

$$CV(\widetilde{P}_{MZ1,f},\widetilde{P}_{MZ2,f})=\widetilde{\widetilde{\Phi}}_{ff}=\widetilde{a}_f^2(q)+\widetilde{b}_f^2(y)+\widetilde{f}_m^2x_f+2\widetilde{a}_f\widetilde{b}_f r+2\widetilde{a}_f\widetilde{f}_f w_f+2\widetilde{b}_f\widetilde{f}_f v_f+\widetilde{d}_f^2+\widetilde{t}_f^2+\widetilde{s}_f^2$$

<u>DZ Twins:</u> $P-P$

3. $CV(DZM,DZM)=\Omega_{mm}=a_m^2(q-.5)+b_m^2(y-.5)+x_m+2a_m b_m r+2a_m w_m+2b_m v_m+.25d_m^2+t_m^2+s_m^2$
4. $CV(DZF,DZF)=\Omega_{ff}=a_f^2(q-.5)+b_f^2(y-.5)+x_f+2a_f b_f r+2a_f w_f+2b_f v_f+.25d_f^2+t_f^2+s_f^2$
5. $CV(DZM,DZF)=\Omega_{mf}=a_m a_f(q-.5)+b_m b_f(y-.5)+x_{mf}+a_m b_f r+a_f b_m r+a_m w_f+a_f w_m+b_m v_f+b_f v_m$
$+z_d d_m d_f+z_t t_m t_f+z_s s_m s_f$
where $z_d\le .25$, $z_t\le 1$, and $z_s\le 1$

<u>DZ Twins:</u> $P-\widetilde{P}$

$$CV(P_{DZ1,m},\widetilde{P}_{DZ2,m})=\widetilde{\Omega}_{mm}=a_m\widetilde{a}_m(q-.5)+b_m\widetilde{b}_m(y-.5)+\widetilde{f}_m(x_m)+\widetilde{a}_m b_m r+a_m\widetilde{b}_m r+\widetilde{a}_m w_m+a_m\widetilde{f}_m w_m$$
$$+\widetilde{b}_m v_m+b_m\widetilde{f}_m v_m+.25d_m\widetilde{d}_m+s_m\widetilde{s}_m+t_m\widetilde{t}_m$$

$$CV(P_{DZ1.f},\widetilde{P}_{DZ2.f})=\widetilde{\Omega}_{ff}=a_f\widetilde{a}_f(q-.5)+b_f\widetilde{b}_f(y-.5)+\widetilde{f}_f(x_f)+\widetilde{a}_f b_f r+a_f\widetilde{b}_f r+\widetilde{a}_f w_f+a_f\widetilde{f}_f w_f$$
$$+\widetilde{b}_f v_f+b_f\widetilde{f}_f v_f+.25d_f\widetilde{d}_f+s_f\widetilde{s}_f+t_f\widetilde{t}_f$$

$$CV(\widetilde{P}_{DZ2.f},P_{DZ1.m})=\widetilde{\Omega}_{fm}=a_m\widetilde{a}_f(q-.5)+b_m\widetilde{b}_f(y-.5)+\widetilde{f}_f(x_{mf})+a_m\widetilde{b}_f r+\widetilde{a}_f b_m r+a_m\widetilde{f}_f w_f+\widetilde{a}_f w_m$$
$$+b_m\widetilde{f}_f v_f+\widetilde{b}_f v_m+z_d d_m\widetilde{d}_f+z_t t_m\widetilde{t}_f+z_s s_m\widetilde{s}_f$$

$$CV(\widetilde{P}_{DZ2.m},P_{DZ1.f})=\widetilde{\Omega}_{mf}=a_f\widetilde{a}_m(q-.5)+b_f\widetilde{b}_m(y-.5)+\widetilde{f}_m(x_{mf})+a_f\widetilde{b}_m r+\widetilde{a}_m b_f r+a_f\widetilde{f}_m w_m+\widetilde{a}_m w_f$$
$$+b_f\widetilde{f}_m v_m+\widetilde{b}_m v_f+z_d d_f\widetilde{d}_m+z_t t_f\widetilde{t}_m+z_s s_f\widetilde{s}_m$$

<u>DZ Twins:</u> $\widetilde{P}-\widetilde{P}$

$$CV(\widetilde{P}_{DZ1,m},\widetilde{P}_{DZ2,m})=\widetilde{\widetilde{\Omega}}_{mm}=\widetilde{a}_m^2(q-.5)+\widetilde{b}_m^2(y-.5)+\widetilde{f}_m^2x_m+2\widetilde{a}_m\widetilde{b}_m r+2\widetilde{a}_m\widetilde{f}_m w_m+2\widetilde{b}_m\widetilde{f}_m v_m+.25\widetilde{d}_m^2+\widetilde{t}_m^2+\widetilde{s}_m^2$$

$$CV(\widetilde{P}_{DZ1,f},\widetilde{P}_{DZ2,f})=\widetilde{\widetilde{\Omega}}_{ff}=\widetilde{a}_f^2(q-.5)+\widetilde{b}_f^2(y-.5)+\widetilde{f}_f^2x_f+2\widetilde{a}_f\widetilde{b}_f r+2\widetilde{a}_f\widetilde{f}_f w_f+2\widetilde{b}_f\widetilde{f}_f v_f+.25\widetilde{d}_f^2+\widetilde{t}_f^2+\widetilde{s}_f^2$$

$$CV(\widetilde{P}_{DZ1,m},\widetilde{P}_{DZ2,f})=\widetilde{\widetilde{\Omega}}_{mf}=\widetilde{a}_m\widetilde{a}_f(q-.5)+\widetilde{b}_m\widetilde{b}_f(y-.5)+\widetilde{f}_m\widetilde{f}_f x_{mf}+\widetilde{a}_m\widetilde{b}_f r+\widetilde{a}_f\widetilde{b}_m r+\widetilde{a}_m\widetilde{f}_f w_f+\widetilde{a}_f\widetilde{f}_m w_m$$
$$+\widetilde{b}_m\widetilde{f}_f v_f+\widetilde{b}_f\widetilde{f}_m v_m+z_d\widetilde{d}_m\widetilde{d}_f+z_t\widetilde{t}_m\widetilde{t}_f+z_s\widetilde{s}_m\widetilde{s}_f$$

<u>Siblings:</u> $P-P$

6. $CV(SibM,SibM)=\Xi_{mm}=\Omega_{mm}-t_m^2$
7. $CV(SibF,SibF)=\Xi_{ff}=\Omega_{ff}-t_f^2$
8. $CV(SibM,SibF)=\Xi_{mf}=\Omega_{mf}-z_t t_m t_f$

<u>Siblings:</u> $P-\widetilde{P}$

$CV(P_{Sib1.m},\widetilde{P}_{Sib2.m})=\widetilde{\Xi}_{mm}=\widetilde{\Omega}_{mm}-\widetilde{t}_m t_m$

$CV(P_{DZ1.f},\widetilde{P}_{DZ2.f})=\widetilde{\Xi}_{ff}=\widetilde{\Omega}_{ff}-\widetilde{t}_f t_f$

$CV(\widetilde{P}_{DZ1.f},P_{DZ2.m})=\widetilde{\Xi}_{fm}=\widetilde{\Omega}_{fm}-z_t t_m \widetilde{t}_f$

$CV(\widetilde{P}_{DZ1.m},P_{DZ2.f})=\widetilde{\Xi}_{mf}=\widetilde{\Omega}_{mf}-z_t t_f \widetilde{t}_m$

<u>Siblings:</u> $\widetilde{P}-\widetilde{P}$

$CV(\widetilde{P}_{Sib1.m},\widetilde{P}_{Sib2.m})=\widetilde{\widetilde{\Xi}}_{mm}=\widetilde{\widetilde{\Omega}}_{mm}-\widetilde{t}_m^2$

$CV(\widetilde{P}_{DZ1.f},\widetilde{P}_{DZ2.f})=\widetilde{\widetilde{\Xi}}_{ff}=\widetilde{\widetilde{\Omega}}_{ff}-\widetilde{t}_f^2$

$CV(\widetilde{P}_{DZ1.m},\widetilde{P}_{DZ2.f})=\widetilde{\widetilde{\Xi}}_{mf}=\widetilde{\widetilde{\Omega}}_{mf}-z_t\widetilde{t}_m\widetilde{t}_f$

<u>Spouses</u>

9. $CV(Spouse)=\tau_m^2 d\tau_f^2$

<u>Parent-offspring</u>

10. $CV(Fa,Son)=\Delta_{Mm}=.5a_m(\delta_m)+.5a_m(\widetilde{\delta}_f d\tau_m^2)+.5b_m(\pi_m)+.5b_m(\widetilde{\pi}_f d\tau_m^2)+m\sigma_m^2+o(\tau_m^2 d\tau_f^2)$

11. $CV(Fa,Dau)=\Delta_{Mf}=.5a_f(\delta_m)+.5a_f(\widetilde{\delta}_f d\tau_m^2)+.5b_f(\pi_m)+.5b_f(\widetilde{\pi}_f d\tau_m^2)+n\sigma_m^2+p(\tau_m^2 d\tau_f^2)$

12. $CV(Mo,Son)=\Delta_{Fm}=.5a_m(\delta_f)+.5a_m(\widetilde{\delta}_m d\tau_f^2)+.5b_m(\pi_f)+.5b_m(\widetilde{\pi}_m d\tau_f^2)+o\sigma_f^2+m(\tau_f^2 d\tau_m^2)$

13. $CV(Mo,Dau)=\Delta_{Ff}=.5a_f(\delta_f)+.5a_f(\widetilde{\delta}_m d\tau_f^2)+.5b_f(\pi_f)+.5b_f(\widetilde{\pi}_m d\tau_f^2)+p\sigma_f^2+n(\tau_f^2 d\tau_m^2)$

$CV(P_{Fa},\widetilde{P}_{Son})=\widetilde{\Delta}_{Mm}=.5\widetilde{a}_m(\delta_m)+.5\widetilde{a}_m(\widetilde{\delta}_f d\tau_m^2)+.5\widetilde{b}_m(\pi_m)+.5\widetilde{b}_m(\widetilde{\pi}_f d\tau_m^2)+m\widetilde{f}_m\sigma_m^2+o(\widetilde{f}_m\tau_m^2 d\tau_f^2)$

$CV(P_{Fa},\widetilde{P}_{Dau})=\widetilde{\Delta}_{Mf}=.5\widetilde{a}_f(\delta_m)+.5\widetilde{a}_f(\widetilde{\delta}_f d\tau_m^2)+.5\widetilde{b}_f(\pi_m)+.5\widetilde{b}_f(\widetilde{\pi}_f d\tau_m^2)+n\widetilde{f}_f\sigma_m^2+p(\widetilde{f}_f\tau_m^2 d\tau_f^2)$

$CV(P_{Mo},\widetilde{P}_{Son})=\widetilde{\Delta}_{Fm}=.5\widetilde{a}_m(\delta_f)+.5\widetilde{a}_m(\widetilde{\delta}_m d\tau_f^2)+.5\widetilde{b}_m(\pi_f)+.5\widetilde{b}_m(\widetilde{\pi}_m d\tau_f^2)+o\widetilde{f}_m\sigma_f^2+m(\widetilde{f}_m\tau_f^2 d\tau_m^2)$

$CV(P_{Mo},\widetilde{P}_{Dau})=\widetilde{\Delta}_{Ff}=.5\widetilde{a}_f(\delta_f)+.5\widetilde{a}_f(\widetilde{\delta}_m d\tau_f^2)+.5\widetilde{b}_f(\pi_f)+.5\widetilde{b}_f(\widetilde{\pi}_m d\tau_f^2)+p\widetilde{f}_f\sigma_f^2+n(\widetilde{f}_f\tau_f^2 d\tau_m^2)$

<u>MZ Uncles</u>

14. $CV(Nephew,MZM)=\Gamma_{mM}=.5a_m\delta_m+.5a_m\widetilde{\delta}_f d\widetilde{\Phi}_{mm}+.5b_m\pi_m+.5b_m\widetilde{\pi}_f d\widetilde{\Phi}_{mm}+m\Phi_{mm}+o\tau_f^2 d\widetilde{\Phi}_{mm}$

15. $CV(Niece,MZM)=\Gamma_{fM}=.5a_f\delta_m+.5a_f\widetilde{\delta}_f d\widetilde{\Phi}_{mm}+.5b_f\pi_m+.5b_f\widetilde{\pi}_f d\widetilde{\Phi}_{mm}+n\Phi_{mm}+p\tau_f^2 d\widetilde{\Phi}_{mm}$

$CV(P_{neph},\widetilde{P}_{MZ,m})=\widetilde{\Gamma}_{mM}=.5a_m\widetilde{\delta}_m+.5a_m\widetilde{\delta}_f d\widetilde{\widetilde{\Phi}}_{mm}+.5b_m\widetilde{\pi}_m+.5b_m\widetilde{\pi}_f d\widetilde{\widetilde{\Phi}}_{mm}+m\widetilde{\Phi}_{mm}+o\tau_f^2 d\widetilde{\widetilde{\Phi}}_{mm}$

$CV(P_{niece},\widetilde{P}_{MZ,m})=\widetilde{\Gamma}_{fM}=.5a_f\widetilde{\delta}_m+.5a_f\widetilde{\delta}_f d\widetilde{\widetilde{\Phi}}_{mm}+.5b_f\widetilde{\pi}_m+.5b_f\widetilde{\pi}_f d\widetilde{\widetilde{\Phi}}_{mm}+n\widetilde{\Phi}_{mm}+p\tau_f^2 d\widetilde{\widetilde{\Phi}}_{mm}$

<u>MZ Aunts</u>

16. $CV(Nephew,MZF)=\Gamma_{mF}=.5a_m\delta_f+.5a_m\widetilde{\delta}_m d\widetilde{\Phi}_{ff}+.5b_m\pi_f+.5b_m\widetilde{\pi}_m d\widetilde{\Phi}_{ff}+o\Phi_{ff}+m\tau_m^2 d\widetilde{\Phi}_{ff}$

17. $CV(Niece,MZF)=\Gamma_{fF}=.5a_f\delta_f+.5a_f\widetilde{\delta}_m d\widetilde{\Phi}_{ff}+.5b_f\pi_f+.5b_f\widetilde{\pi}_m d\widetilde{\Phi}_{ff}+p\Phi_{ff}+n\tau_m^2 d\widetilde{\Phi}_{ff}$

$CV(P_{neph},\widetilde{P}_{MZ,f})=\widetilde{\Gamma}_{mF}=.5a_m\widetilde{\delta}_f+.5a_m\widetilde{\delta}_m d\widetilde{\widetilde{\Phi}}_{ff}+.5b_m\widetilde{\pi}_f+.5b_m\widetilde{\pi}_m d\widetilde{\widetilde{\Phi}}_{ff}+o\widetilde{\Phi}_{ff}+m\tau_m^2 d\widetilde{\widetilde{\Phi}}_{ff}$

$$CV(P_{niece},\widetilde{P}_{MZ,f}) = \widetilde{\Gamma}_{fF} = .5a_f\widetilde{\delta}_f + .5a_f\widetilde{\delta}_m d\widetilde{\widetilde{\Phi}}_{ff} + .5b_f\widetilde{\pi}_f + .5b_f\widetilde{\pi}_m d\widetilde{\widetilde{\Phi}}_{ff} + p\widetilde{\Phi}_{ff} + n\tau_m^2 d\widetilde{\widetilde{\Phi}}_{ff}$$

<u>DZ Uncles</u>

18. $CV(Nephew,DZMM) = \Theta_{mMM} = .5a_m\theta_{\bullet m} + .5a_m\widetilde{\delta}_f d\widetilde{\Omega}_{mm} + .5b_m\varphi_{\bullet m} + .5b_m\widetilde{\pi}_f d\widetilde{\Omega}_{mm} + m\Omega_{mm} + o\tau_f^2 d\widetilde{\Omega}_{mm}$
19. $CV(Niece,DZMM) = \Theta_{fMM} = .5a_f\theta_{\bullet m} + .5a_f\widetilde{\delta}_f d\widetilde{\Omega}_{mm} + .5b_f\varphi_{\bullet m} + .5b_f\widetilde{\pi}_f d\widetilde{\Omega}_{mm} + n\Omega_{mm} + p\tau_f^2 d\widetilde{\Omega}_{mm}$
20. $CV(Nephew,DZFM) = \Theta_{mFM} = .5a_m\theta_{\bullet m} + .5a_m\widetilde{\delta}_m d\widetilde{\Omega}_{fm} + .5b_m\varphi_{\bullet m} + .5b_m\widetilde{\pi}_m d\widetilde{\Omega}_{fm} + o\Omega_{mf} + m\tau_m^2 d\widetilde{\Omega}_{fm}$
21. $CV(Niece,DZFM) = \Theta_{fFM} = .5a_f\theta_{\bullet m} + .5a_f\widetilde{\delta}_m d\widetilde{\Omega}_{fm} + .5b_f\varphi_{\bullet m} + .5b_f\widetilde{\pi}_m d\widetilde{\Omega}_{fm} + p\Omega_{mf} + n\tau_m^2 d\widetilde{\Omega}_{fm}$

$$CV(P_{neph},\widetilde{P}_{DZ,m}) = \widetilde{\Theta}_{mMM} = .5a_m\widetilde{\theta}_{\bullet m} + .5a_m\widetilde{\delta}_f d\widetilde{\widetilde{\Omega}}_{mm} + .5b_m\widetilde{\varphi}_{\bullet m} + .5b_m\widetilde{\pi}_f d\widetilde{\widetilde{\Omega}}_{mm} + m\widetilde{\Omega}_{mm} + o\tau_f^2 d\widetilde{\widetilde{\Omega}}_{mm}$$
$$CV(P_{niece},\widetilde{P}_{DZ,m}) = \widetilde{\Theta}_{fMM} = .5a_f\widetilde{\theta}_{\bullet m} + .5a_f\widetilde{\delta}_f d\widetilde{\widetilde{\Omega}}_{mm} + .5b_f\widetilde{\varphi}_{\bullet m} + .5b_f\widetilde{\pi}_f d\widetilde{\widetilde{\Omega}}_{mm} + n\widetilde{\Omega}_{mm} + p\tau_f^2 d\widetilde{\widetilde{\Omega}}_{mm}$$
$$CV(P_{neph},\widetilde{P}_{DZ,fm}) = \widetilde{\Theta}_{mFM} = .5a_m\widetilde{\theta}_{\bullet m} + .5a_m\widetilde{\delta}_m d\widetilde{\widetilde{\Omega}}_{mf} + .5b_m\widetilde{\varphi}_{\bullet m} + .5b_m\widetilde{\pi}_m d\widetilde{\widetilde{\Omega}}_{mf} + o\widetilde{\Omega}_{mf} + m\tau_m^2 d\widetilde{\widetilde{\Omega}}_{mf}$$
$$CV(P_{niece},\widetilde{P}_{DZ,fm}) = \widetilde{\Theta}_{fFM} = .5a_f\widetilde{\theta}_{\bullet m} + .5a_f\widetilde{\delta}_m d\widetilde{\widetilde{\Omega}}_{mf} + .5b_f\widetilde{\varphi}_{\bullet m} + .5b_f\widetilde{\pi}_m d\widetilde{\widetilde{\Omega}}_{mf} + p\widetilde{\Omega}_{mf} + n\tau_m^2 d\widetilde{\widetilde{\Omega}}_{mf}$$

<u>DZ Aunts</u>

22. $CV(Nephew,DZFF) = \Theta_{mFF} = .5a_m\theta_{\bullet f} + .5a_m\widetilde{\delta}_m d\widetilde{\Omega}_{ff} + .5b_m\varphi_{\bullet f} + .5b_m\widetilde{\pi}_m d\widetilde{\Omega}_{ff} + o\Omega_{ff} + m\tau_m^2 d\widetilde{\Omega}_{ff}$
23. $CV(Niece,DZFF) = \Theta_{fFF} = .5a_f\theta_{\bullet f} + .5a_f\widetilde{\delta}_m d\widetilde{\Omega}_{ff} + .5b_f\varphi_{\bullet f} + .5b_f\widetilde{\pi}_m d\widetilde{\Omega}_{ff} + p\Omega_{ff} + n\tau_m^2 d\widetilde{\Omega}_{ff}$
24. $CV(Nephew,DZMF) = \Theta_{mMF} = .5a_m\theta_{\bullet f} + .5a_m\widetilde{\delta}_f d\widetilde{\Omega}_{mf} + .5b_m\varphi_{\bullet f} + .5b_m\widetilde{\pi}_f d\widetilde{\Omega}_{mf} + m\Omega_{mf} + o\tau_f^2 d\widetilde{\Omega}_{mf}$
25. $CV(Niece,DZMF) = \Theta_{fMF} = .5a_f\theta_{\bullet f} + .5a_f\widetilde{\delta}_f d\widetilde{\Omega}_{mf} + .5b_f\varphi_{\bullet f} + .5b_f\widetilde{\pi}_f d\widetilde{\Omega}_{mf} + n\Omega_{mf} + p\tau_f^2 d\widetilde{\Omega}_{mf}$

$$CV(P_{neph},\widetilde{P}_{DZ,f}) = \widetilde{\Theta}_{mFF} = .5a_m\widetilde{\theta}_{\bullet f} + .5a_m\widetilde{\delta}_m d\widetilde{\widetilde{\Omega}}_{ff} + .5b_m\widetilde{\varphi}_{\bullet f} + .5b_m\widetilde{\pi}_m d\widetilde{\widetilde{\Omega}}_{ff} + o\widetilde{\Omega}_{ff} + m\tau_m^2 d\widetilde{\widetilde{\Omega}}_{ff}$$
$$CV(P_{niece},\widetilde{P}_{DZ,f}) = \widetilde{\Theta}_{fFF} = .5a_f\widetilde{\theta}_{\bullet f} + .5a_f\widetilde{\delta}_m d\widetilde{\widetilde{\Omega}}_{ff} + .5b_f\widetilde{\varphi}_{\bullet f} + .5b_f\widetilde{\pi}_m d\widetilde{\widetilde{\Omega}}_{ff} + p\widetilde{\Omega}_{ff} + n\tau_m^2 d\widetilde{\widetilde{\Omega}}_{ff}$$
$$CV(P_{neph},\widetilde{P}_{DZ,mf}) = \widetilde{\Theta}_{mMF} = .5a_m\widetilde{\theta}_{\bullet f} + .5a_m\widetilde{\delta}_f d\widetilde{\widetilde{\Omega}}_{mf} + .5b_m\widetilde{\varphi}_{\bullet f} + .5b_m\widetilde{\pi}_f d\widetilde{\widetilde{\Omega}}_{mf} + m\widetilde{\Omega}_{fm} + o\tau_f^2 d\widetilde{\widetilde{\Omega}}_{mf}$$
$$CV(P_{niece},\widetilde{P}_{DZ,mf}) = \widetilde{\Theta}_{fMF} = .5a_f\widetilde{\theta}_{\bullet f} + .5a_f\widetilde{\delta}_f d\widetilde{\widetilde{\Omega}}_{mf} + .5b_f\widetilde{\varphi}_{\bullet f} + .5b_f\widetilde{\pi}_f d\widetilde{\widetilde{\Omega}}_{mf} + n\widetilde{\Omega}_{fm} + p\tau_f^2 d\widetilde{\widetilde{\Omega}}_{mf}$$

<u>Sibling Uncles</u>

26. $CV(Nephew,SibMM) = .5a_m\theta_{\bullet m} + .5a_m\widetilde{\delta}_f d\widetilde{\Xi}_{mm} + .5b_m\varphi_{\bullet m} + .5b_m\widetilde{\pi}_f d\widetilde{\Xi}_{mm} + m\Xi_{mm} + o\tau_f^2 d\widetilde{\Xi}_{mm}$
27. $CV(Niece,SibMM) = .5a_f\theta_{\bullet m} + .5a_f\widetilde{\delta}_f d\widetilde{\Xi}_{mm} + .5b_f\varphi_{\bullet m} + .5b_f\widetilde{\pi}_f d\widetilde{\Xi}_{mm} + n\Xi_{mm} + p\tau_f^2 d\widetilde{\Xi}_{mm}$
28. $CV(Nephew,SibFM) = .5a_m\theta_{\bullet m} + .5a_m\widetilde{\delta}_m d\widetilde{\Xi}_{fm} + .5b_m\varphi_{\bullet m} + .5b_m\widetilde{\pi}_m d\widetilde{\Xi}_{fm} + o\Xi_{mf} + m\tau_m^2 d\widetilde{\Xi}_{fm}$
29. $CV(Niece,SibFM) = .5a_f\theta_{\bullet m} + .5a_f\widetilde{\delta}_m d\widetilde{\Xi}_{fm} + .5b_f\varphi_{\bullet m} + .5b_f\widetilde{\pi}_m d\widetilde{\Xi}_{fm} + p\Xi_{mf} + n\tau_m^2 d\widetilde{\Xi}_{fm}$

<u>Sibling Aunts</u>

30. $CV(Nephew,SibFF) = .5a_m\theta_{\bullet f} + .5a_m\widetilde{\delta}_m d\widetilde{\Xi}_{ff} + .5b_m\varphi_{\bullet f} + .5b_m\widetilde{\pi}_m d\widetilde{\Xi}_{ff} + o\Xi_{ff} + m\tau_m^2 d\widetilde{\Xi}_{ff}$
31. $CV(Niece,SibFF) = .5a_f\theta_{\bullet f} + .5a_f\widetilde{\delta}_m d\widetilde{\Xi}_{ff} + .5b_f\varphi_{\bullet f} + .5b_f\widetilde{\pi}_m d\widetilde{\Xi}_{ff} + p\Xi_{ff} + n\tau_m^2 d\widetilde{\Xi}_{ff}$
32. $CV(Nephew,SibMF) = .5a_m\theta_{\bullet f} + .5a_m\widetilde{\delta}_f d\widetilde{\Xi}_{mf} + .5b_m\varphi_{\bullet f} + .5b_m\widetilde{\pi}_f d\widetilde{\Xi}_{mf} + m\Xi_{mf} + o\tau_f^2 d\widetilde{\Xi}_{mf}$
33. $CV(Niece,SibMF) = .5a_f\theta_{\bullet f} + .5a_f\widetilde{\delta}_f d\widetilde{\Xi}_{mf} + .5b_f\varphi_{\bullet f} + .5b_f\widetilde{\pi}_f d\widetilde{\Xi}_{mf} + n\Xi_{mf} + p\tau_f^2 d\widetilde{\Xi}_{mf}$

MZM Cousins

34. $CV(M.Cous, M.Cous, MZM) = .5a_m(\xi_{\bullet Mm} + \tilde{\delta}_f d\tilde{\Gamma}_{mM}) + .5b_m(\alpha_{\bullet Mm} + \tilde{\pi}_f d\tilde{\Gamma}_{mM}) + m\Gamma_{mM} + o\tau_f^2 d\tilde{\Gamma}_{mM}$

35. $CV(M.Cous, F.Cous, MZM) = .5a_m(\xi_{\bullet Mf} + \tilde{\delta}_f d\tilde{\Gamma}_{fM}) + .5b_m(\alpha_{\bullet Mf} + \tilde{\pi}_f d\tilde{\Gamma}_{fM}) + m\Gamma_{fM} + o\tau_f^2 d\tilde{\Gamma}_{fM}$

36. $CV(F.Cous, F.Cous, MZM) = .5a_f(\xi_{\bullet Mf} + \tilde{\delta}_f d\tilde{\Gamma}_{fM}) + .5b_f(\alpha_{\bullet Mf} + \tilde{\pi}_f d\tilde{\Gamma}_{fM}) + n\Gamma_{fM} + p\tau_f^2 d\tilde{\Gamma}_{fM}$

MZF Cousins

37. $CV(M.Cous, M.Cous, MZF) = .5a_m(\xi_{\bullet Fm} + \tilde{\delta}_m d\tilde{\Gamma}_{mF}) + .5b_m(\alpha_{\bullet Fm} + \tilde{\pi}_m d\tilde{\Gamma}_{mF}) + o\Gamma_{mF} + m\tau_m^2 d\tilde{\Gamma}_{mF}$

38. $CV(M.Cous, F.Cous, MZF) = .5a_m(\xi_{\bullet Ff} + \tilde{\delta}_m d\tilde{\Gamma}_{fF}) + .5b_m(\alpha_{\bullet Ff} + \tilde{\pi}_m d\tilde{\Gamma}_{fF}) + o\Gamma_{fF} + m\tau_m^2 d\tilde{\Gamma}_{fF}$

39. $CV(F.Cous, F.Cous, MZF) = .5a_f(\xi_{\bullet Ff} + \tilde{\delta}_m d\tilde{\Gamma}_{fF}) + .5b_f(\alpha_{\bullet Ff} + \tilde{\pi}_m d\tilde{\Gamma}_{fF}) + p\Gamma_{fF} + n\tau_m^2 d\tilde{\Gamma}_{fF}$

DZM Cousins

40. $CV(M.Cous, M.Cous, DZMM) = .5a_m(\lambda_{\bullet Mm} + \tilde{\delta}_f d\tilde{\Theta}_{mMM}) + .5b_m(\beta_{\bullet Mm} + \tilde{\pi}_f d\tilde{\Theta}_{mMM}) + m\Theta_{mMM} + o\tau_f^2 d\tilde{\Theta}_{mMM}$

41. $CV(M.Cous, F.Cous, DZMM) = .5a_m(\lambda_{\bullet Mf} + \tilde{\delta}_f d\tilde{\Theta}_{fMM}) + .5b_m(\beta_{\bullet Mf} + \tilde{\pi}_f d\tilde{\Theta}_{fMM}) + m\Theta_{fMM} + o\tau_f^2 d\tilde{\Theta}_{fMM}$

42. $CV(F.Cous, F.Cous, DZMM) = .5a_f(\lambda_{\bullet Mf} + \tilde{\delta}_f d\tilde{\Theta}_{fMM}) + .5b_f(\beta_{\bullet Mf} + \tilde{\pi}_f d\tilde{\Theta}_{fMM}) + n\Theta_{fMM} + p\tau_f^2 d\tilde{\Theta}_{fMM}$

DZF Cousins

43. $CV(M.Cous, M.Cous, DZFF) = .5a_m(\lambda_{\bullet Fm} + \tilde{\delta}_m d\tilde{\Theta}_{mFF}) + .5b_m(\beta_{\bullet Fm} + \tilde{\pi}_m d\tilde{\Theta}_{mFF}) + o\Theta_{mFF} + m\tau_m^2 d\tilde{\Theta}_{mFF}$

44. $CV(M.Cous, F.Cous, DZFF) = .5a_m(\lambda_{\bullet Ff} + \tilde{\delta}_m d\tilde{\Theta}_{fFF}) + .5b_m(\beta_{\bullet Ff} + \tilde{\pi}_m d\tilde{\Theta}_{fFF}) + o\Theta_{fFF} + m\tau_m^2 d\tilde{\Theta}_{fFF}$

45. $CV(F.Cous, F.Cous, DZFF) = .5a_f(\lambda_{\bullet Ff} + \tilde{\delta}_m d\tilde{\Theta}_{fFF}) + .5b_f(\beta_{\bullet Ff} + \tilde{\pi}_m d\tilde{\Theta}_{fFF}) + p\Theta_{fFF} + n\tau_m^2 d\tilde{\Theta}_{fFF}$

DZMF Cousins

46. $CV(M.Cous, M.Cous, DZMF) = .5a_m(\lambda_{\bullet Fm} + \tilde{\delta}_f d\tilde{\Theta}_{mMF}) + .5b_m(\beta_{\bullet Fm} + \tilde{\pi}_f d\tilde{\Theta}_{mMF}) + m\Theta_{mMF} + o\tau_f^2 d\tilde{\Theta}_{mMF}$

47. $CV(M.Cous, F.Cous, DZMF) = .5a_m(\lambda_{\bullet Ff} + \tilde{\delta}_f d\tilde{\Theta}_{fMF}) + .5b_m(\beta_{\bullet Ff} + \tilde{\pi}_f d\tilde{\Theta}_{fMF}) + m\Theta_{fMF} + o\tau_f^2 d\tilde{\Theta}_{fMF}$

48. $CV(F.Cous, M.Cous, DZMF) = .5a_f(\lambda_{\bullet Fm} + \tilde{\delta}_f d\tilde{\Theta}_{mMF}) + .5b_f(\beta_{\bullet Fm} + \tilde{\pi}_f d\tilde{\Theta}_{mMF}) + n\Theta_{mMF} + p\tau_f^2 d\tilde{\Theta}_{mMF}$

49. $CV(F.Cous, F.Cous, DZMF) = .5a_f(\lambda_{\bullet Ff} + \tilde{\delta}_f d\tilde{\Theta}_{fMF}) + .5b_f(\beta_{\bullet Ff} + \tilde{\pi}_f d\tilde{\Theta}_{fMF}) + n\Theta_{fMF} + p\tau_f^2 d\tilde{\Theta}_{fMF}$

Grandparents

50. $CV(PatGfa, Grnson) =$

$.25a_m(\delta_m + \tilde{\delta}_f d\tau_m^2 + 2\tilde{\delta}_f d\tilde{\Delta}_{Mm}) + .25b_m(\pi_m + \tilde{\pi}_f d\tau_m^2 + 2\tilde{\pi}_f d\tilde{\Delta}_{Mm}) + m\Delta_{Mm} + o(\tilde{\Delta}_{Mm} d\tau_f^2)$

51. $CV(MatGfa, Grnson) =$

$.25a_m(\delta_m + \tilde{\delta}_f d\tau_m^2 + 2\tilde{\delta}_m d\tilde{\Delta}_{Mf}) + .25b_m(\pi_m + \tilde{\pi}_f d\tau_m^2 + 2\tilde{\pi}_m d\tilde{\Delta}_{Mf}) + o\Delta_{Mf} + m(\tilde{\Delta}_{Mf} d\tau_m^2)$

52. $CV(PatGmo, Grnson) =$

$.25a_m(\delta_f + \tilde{\delta}_m d\tau_f^2 + 2\tilde{\delta}_f d\tilde{\Delta}_{Fm}) + .25b_m(\pi_f + \tilde{\pi}_m d\tau_f^2 + 2\tilde{\pi}_f d\tilde{\Delta}_{Fm}) + m\Delta_{Fm} + o(\tilde{\Delta}_{Fm} d\tau_f^2)$

53. $CV(MatGmo, Grnson) =$

$.25a_m(\delta_f + \tilde{\delta}_m d\tau_f^2 + 2\tilde{\delta}_m d\tilde{\Delta}_{Ff}) + .25b_m(\pi_f + \tilde{\pi}_m d\tau_f^2 + 2\tilde{\pi}_m d\tilde{\Delta}_{Ff}) + o\Delta_{Ff} + m(\tilde{\Delta}_{Ff} d\tau_m^2)$

54. $CV(PatGfa, Grndau) =$

$$.25a_f(\delta_m + \tilde{\delta}_f d\tau_m^2 + 2\tilde{\delta}_f d\tilde{\Delta}_{Mm}) + .25b_f(\pi_m + \tilde{\pi}_f d\tau_m^2 + 2\tilde{\pi}_f d\tilde{\Delta}_{Mm}) + n\Delta_{Mm} + p(\tilde{\Delta}_{Mm} d\tau_f^2)$$

55. $CV(MatGfa, Grndau) =$

$$.25a_f(\delta_m + \tilde{\delta}_f d\tau_m^2 + 2\tilde{\delta}_m d\tilde{\Delta}_{Mf}) + .25b_f(\pi_m + \tilde{\pi}_f d\tau_m^2 + 2\tilde{\pi}_m d\tilde{\Delta}_{Mf}) + p\Delta_{Mf} + n(\tilde{\Delta}_{Mf} d\tau_m^2)$$

56. $CV(PatGmo, Grndau) =$

$$.25a_f(\delta_f + \tilde{\delta}_m d\tau_f^2 + 2\tilde{\delta}_f d\tilde{\Delta}_{Fm}) + .25b_f(\pi_f + \tilde{\pi}_m d\tau_f^2 + 2\tilde{\pi}_f d\tilde{\Delta}_{Fm}) + n\Delta_{Fm} + p(\tilde{\Delta}_{Fm} d\tau_f^2)$$

57. $CV(MatGmo, Grndau) =$

$$.25a_f(\delta_f + \tilde{\delta}_m d\tau_f^2 + 2\tilde{\delta}_m d\tilde{\Delta}_{Ff}) + .25b_f(\pi_f + \tilde{\pi}_m d\tau_f^2 + 2\tilde{\pi}_m d\tilde{\Delta}_{Ff}) + p\Delta_{Ff} + n(\tilde{\Delta}_{Ff} d\tau_m^2)$$

<u>Twins-in-law</u>

58. $CV(MZM, MZM.Spouse) = \tau_f^2 d\tilde{\Phi}_{mm}$
59. $CV(MZF, MZF.Spouse) = \tau_m^2 d\tilde{\Phi}_{ff}$
60. $CV(DZM, DZM.Spouse) = \tau_f^2 d\tilde{\Omega}_{mm}$
61. $CV(DZF, DZF.Spouse) = \tau_m^2 d\tilde{\Omega}_{ff}$
62. $CV(DZM, DZF.Spouse) = \tau_m^2 d\tilde{\Omega}_{fm}$
63. $CV(DZF, DZM.Spouse) = \tau_f^2 d\tilde{\Omega}_{mf}$

<u>Sibs-in-law</u>

64. $CV(Bro, Bro.Spouse) = \tau_f^2 d\tilde{\Xi}_{mm}$
65. $CV(Sis, Sis.Spouse) = \tau_m^2 d\tilde{\Xi}_{ff}$
66. $CV(Bro, Sis.Spouse) = \tau_m^2 d\tilde{\Xi}_{fm}$
67. $CV(Sis, Bro.Spouse) = \tau_f^2 d\tilde{\Xi}_{mf}$

<u>Spouses-in-law</u>

68. $CV(MZM.Spouse, MZM.Spouse) = \tau_f^4 d^2 \tilde{\tilde{\Phi}}_{mm}$
69. $CV(MZF.Spouse, MZF.Spouse) = \tau_m^4 d^2 \tilde{\tilde{\Phi}}_{ff}$
70. $CV(DZM.Spouse, DZM.Spouse) = \tau_f^4 d^2 \tilde{\tilde{\Omega}}_{mm}$
71. $CV(DZF.Spouse, DZF.Spouse) = \tau_m^4 d^2 \tilde{\tilde{\Omega}}_{ff}$
72. $CV(DZM.Spouse, DZF.Spouse) = \tau_f^2 \tau_m^2 d^2 \tilde{\tilde{\Omega}}_{mf}$

<u>Parents-in-law</u>

73. $CV(Wife, Fa) = \tau_f^2 d\tilde{\Delta}_{Mm}$
74. $CV(Wife, Mo) = \tau_f^2 d\tilde{\Delta}_{Fm}$
75. $CV(Husband, Fa) = \tau_m^2 d\tilde{\Delta}_{Mf}$

76. $CV(Husband, Mo) = \tau_m^2 d\widetilde{\Delta}_{Ff}$

<u>MZ Avuncular In-laws</u>

77. $CV(Nephew, MZF.Spouse) = \tau_m^2 d\widetilde{\Gamma}_{mF}$

78. $CV(Niece, MZF.Spouse) = \tau_m^2 d\widetilde{\Gamma}_{fF}$

79. $CV(Nephew, MZM.Spouse) = \tau_f^2 d\widetilde{\Gamma}_{mM}$

80. $CV(Niece, MZM.Spouse) = \tau_f^2 d\widetilde{\Gamma}_{fM}$

<u>DZ Aunts-in-law</u>

81. $CV(Nephew, DZMM.Spouse) = \tau_f^2 d\widetilde{\Theta}_{mMM}$

82. $CV(Niece, DZMM.Spouse) = \tau_f^2 d\widetilde{\Theta}_{fMM}$

83. $CV(Nephew, DZFM.Spouse) = \tau_f^2 d\widetilde{\Theta}_{mFM}$

84. $CV(Niece, DZFM.Spouse) = \tau_f^2 d\widetilde{\Theta}_{fFM}$

<u>DZ Uncles-in-law</u>

85. $CV(Nephew, DZFF.Spouse) = \tau_m^2 d\widetilde{\Theta}_{mFF}$

86. $CV(Niece, DZFF.Spouse) = \tau_m^2 d\widetilde{\Theta}_{fFF}$

87. $CV(Nephew, DZMF.Spouse) = \tau_m^2 d\widetilde{\Theta}_{mMF}$

88. $CV(Niece, DZMF.Spouse) = \tau_m^2 d\widetilde{\Theta}_{fMF}$