**Table S1**

**1. Infant Intragroup Transmission Possibilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | *Bonobo sex:*I[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)]*Vertical:* I(βAfi) | I[(βAf)+ (βAm) +(βsAm) + (βsAm) + (βI)] | 0 | I[(βAf)+ (βAm) +(βsAm) + (βsAm) + (βI)] | I[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MM | *Vertical:* I(βAfi) | I[(βAf)+ (βAm) +(βsAm) + (βsAm) + (βI)] | 0 | I[(βAf)+ (βAm) +(βsAm) + (βsAm) + (βI)] | I[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| UM | *Vertical:* I(βAfi) | I[(βAf)+ (βAm) +(βsAm) + (βsAm) + (βI)] | 0  | I[(βAf)+ (βAm) +(βsAm) + (βsAm) + (βI)] | I[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MO | *Vertical:* I(βAfi) | I[(βAf)+ (βAm) + (βI)] | 0 | I[(βAf)+ (βAm) + (βI)] | I[(βvAm) + (βvAf) + (βvI)] |
| SO*(infants still in the natal group)* | Vertical: I(βAfi) | I[(βAf)+ (βAm) + (βI)] | 0 | I[(βAf)+ (βAm) + (βI)] | I[(βvAm) + (βvAf) + (βvI)] |

**2. Subadult Female Intragroup Transmission Possibilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | sAf[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | sAf[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights*:sAf [βFIGHT (Am + Af + sAm + sAf)]-------------------------------------------*Allomothering and grooming favors:* sAf [βGROOM (Am + Af + sAf)] | sAf[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | I[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MM | sAf[(βAm) *+(βsAm)*]*Subadult males may copulate occasionally* | sAf[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights:* sAf [βFIGHT (Am + Af + sAm + sAf)]-------------------------------------------*Allomothering and grooming favors:* sAf [βGROOM (Am + Af + sAf)] | sAf[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | I[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| UM | sAf[(βAm) *+(βsAm)*]*Subadult males may copulate, but tend to migrate instead* | sAf[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights:*sAf [βFIGHT (Am + Af + sAm + sAf)]-------------------------------------------*Allomothering and grooming favors:*sAf [βGROOM (Am + Af + sAf)] | sAf[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | I[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MO | 0 | 0 | 0 | 0 | 0 |
| SO | 0 | 0 | 0 | 0 | 0 |

#### 3. Subadult Male Intragroup Transmission Possibilities

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | sAm[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | sAm[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights:*Am [βFIGHT (Am + Af + sAm + sAf + I)-------------------------------------------*Grooming favors:*Am [βGROOM (Am + Af + sAm + sAf)] | sAm[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | sAm[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MM | 0 | sAm[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights:*Am [βFIGHT (Am + sAm)]-------------------------------------------*Grooming favors:*Am [βGROOM (Am + Af + sAm + sAf)] | sAm[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | sAm[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| UM | 0 | sAm[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights:*Am [βFIGHT (Am + sAm)]-------------------------------------------*Grooming favors:*Am [βGROOM (Am + Af + sAm + sAf)] | sAm[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | sAm[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MO |  0 | 0 | 0 | 0 | 0 |
| SO |  0 | 0 | 0 | 0 | 0 |

#### 4. Adult Female Intragroup Transmission Possibilities

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | Af[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | Af[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights and infant protection:*Af [βFIGHT (Am + Af + sAm + sAf)]-------------------------------------------*Allomothering and grooming favors:*Af [βGROOM (Am + Af + sAm + sAf)] | Af[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | Af[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MM | *Occasional (rare) subadult copulation:*Af[(βAm) *+(βsAm)*] | Af[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights and infant protection:*Af [βFIGHT (Am + Af + sAm + sAf)]-------------------------------------------*Allomothering and grooming favors:*Af [βGROOM (Am + Af + sAf)] | Af[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | Af[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| UM | *Occasional (rare) subadult copulation:*Af[(βAm) *+(βsAm)*] | Af[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | *Dominance fights and infant protection:*Af [βFIGHT (Am + Af + sAm + sAf)]-------------------------------------------*Allomothering and grooming favors:*Af [βGROOM (Am + Af + sAf)] | Af[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)] | Af[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MO |  Af[(βAm)] | Af[(βAf)+ (βAm) + (βI)] | Few or no agonistic encounters-------------------------------------------*Grooming:*Af [βGROOM (Am )] | Af[(βAf)+ (βAm) + (βI)] | Af[(βvAm) + (βvAf) + (βvI)] |
| SO*Encounters only during breeding seasons* | Af[(βAm)] | Af[(βAm)+ (βI)] | Few or no agonistic encounters-------------------------------------------Grooming:Af [βGROOM(Am )] | Af[(βAf)+ (βAm) + (βI)] | Af[(βvAm) + (βvAf) + (βvI)] |

**5. Adult Male Intragroup Tranmission Possibilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | Am[(βAf)+ (βAm) +(βsAm) + (βsAm)+ (βI)]  | Am[(βAm) +(βAf) + (βsAm) + (βsAf) + (βI)] | Am [βFIGHT (Am + Af + sAm + sAf + I)]-------------------------------------------*Grooming favors:*Am [βGROOM (Am + Af + sAm + sAf + I)] | Am[(βAm) + (βAf) + (βsAm) + (βsAf)+ (βI)] | Am[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)] |
| MM | Am[(βAf)+ +(βsAf)] | Am[(βAm) + (βAf) + (βsAm) +(βsAf)+ (βI)] | Am [βFIGHT (Am + Af + sAm + sAf + I)]------------------------------------------- *Grooming favors:*Am [βGROOM (Am + Af + sAm + sAf + I)] | Am[(βAm) + (βAf) + (βsAm) + (βsAf)+ (βI)] | Am[(βAm) + (βAf) + (βsAm) + (βsAf)+ (βI)] |
| UM | A­m [(βAf) +(βsAf)] | Am[(βAm) + (βAf) + (βsAm) + (βsAf)+ (βI)] | Am [βFIGHT (Am + Af + sAm + sAf + I)]-------------------------------------------*Grooming favors:*Am [βGROOM (Af + sAm + sAf + I)] | Am[(βAm) + (βAf) + (βsAm) + (βsAf)+ (βI)] | Am[(βAm) + (βAf) + (βsAm) + (βsAf)+ (βI)] |
| MO |  Am[(βAf)] | Am[(βAf) +(βI)] | 0------------------------------------------- *Grooming favors:*Am [βGROOM (Af + sAm + sAf + I)] | Am[(βAm) + (βAf) + (βI)] | Am[(βAm) + (βAf) + (βI)] |
| SO*Encounters only during breeding seasons* |  Am[(βAf)] | Am[(βAf)+ (βI)] | 0 | 0 | Am[(βvAf)] |

**6. Infant Intergroup Transmission Possibilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | 0 |  I[(βAm)1,2 + (βAf)1,2 + (βsAm)1,2 + (βsAf)1,2 + (βI) 1,2] | *Infanticidal takeovers:*I1[(βAm)+ (βAf) + (βsAm)] 2 | 0 | I1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MM | 0 | I[(βAm)1,2 + (βAf)1,2 + (βsAm) 1,2 + (βsAf) 1,2 + (βI) 1,2] | *Infanticidal takeovers:*I1[(βAm) + (βAf) + (βsAm)] 2 | 0 | I1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| UM | 0 | I[(βAm)1,2 + (βAf)1,2 + (βsAm) 1,2 + (βsAf)1,2 + (βI) 1,2] | *Infanticidal takeovers:*I1[(βAm)+ (βAf) + (βsAm)] 2 | 0 | I1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MO | 0 | I[(βAm)1,2 + (βAf) 1,2 + (βI) 1,2] | 0 | 0 | I1Δ[(βvAm) + (βvAf) + (βvI)]2 |
| SO*Infants still in the natal group* | 0 |  | 0 | 0 | I1Δ[(βvAm) + (βvAf) + (βvI)]2 |

##### 7. Subdult Female Intergroup Transmission Possibilities

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | a,bεsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | a,b (εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | *Emigrating and immigrating subadult females having fights*:(εsAf) βFIGHT [(Am) + (Af) + (sAm)+ (sAf)]2 & (isAf)βFIGHT [ (Am) + (Af) + (sAm)+ (sAf)]1 | a,b(εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 |  sAf1Δ [(βv Am) + (βvAf) + (βvI)]2 |
| MM | a,b(εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | a,b(εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | *Emigrating and immigrating subadult females having fights*:(εsAf) [βFIGHT (Am) + (Af) + (sAm)+ (sAf)]2 & (isAf) [βFIGHT (Am) + (Af) + (sAm)+ (sAf)]1 | a,b(εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | sAf1Δ[(βvAm) + (βvAf) + (βvI)]2 |
| UM | a,b(εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | a,b(εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | *Emigrating and immigrating subadult females having fights*:(εsAf) [βFIGHT (Am) + (Af) + (sAm)+ (sAf)]2 & (isAf) [βFIGHT (Am) + (Af) + (sAm)+ (sAf)]1 | a,b(εsAf) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (isAf) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)]1 | sAf1Δ[(βvAm) + (βvAf) + (βvI)]2 |
| MO | 0 | 0 | 0 | 0 | 0 |
| SO | 0 | 0 | 0 | 0 | 0 |

*aWhen subadult females are the age class that leaves the natal group*

*bEmigrating and immigrating subadult females having effects on groups 1 and 2***8. Subdult Male Intergroup Transmission Possibilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming | Aerosol | Vector |
| FF*(Bonobos)* | a,b (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] | a,b (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] | a,b (εsAm + iAm) [βFIGHT (Am)1,2 + (Af)1,2 + (sAm) 1,2 + (sAf) 1,2] | a,b (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] |  sAm1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MM | a,b (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] | a,b (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] | a,b (εsAm + iAm) [βFIGHT (βAm)1,2 + (βAf)1,2 + (βsAm) 1,2 + (βsAf) 1,2 + (βI) 1,2] | a,b (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] |  sAm1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| UM | (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] | (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 &(iAm) [(βAm) + (βAf) +(βsAm)+ (βsAf) +(βI)] | (εsAm + iAm) [βFIGHT (βAm)1,2 + (βAf)1,2 + (βsAm) 1,2 + (βsAf) 1,2 + (βI) 1,2] | (εsAm) [(βAm) + (βAf) + (βsAm)+ (βsAf)+ (βI)]2 & (iAm) [(βAm) + (βAf) + (βsAm)+ (βsAf) + (βI)] |  sAm1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MO | 0 | 0 | 0 | 0 | 0 |
| SO | 0 | 0 | 0 | 0 | 0 |

*a When subadult males are the age class that leaves the natal group*

*b Emigrating and immigrating subadult males having effects on groups 1 and 2***9. Adult Female Intergroup Transmission Possibilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | 0 | *Rate at which adult female ranges overlap other groups:*Af[(βAm) + (βAf) + (βsAm) + (βsAf) + (βI)]2 | *Territorial and infant defense:* Af βFIGHT [ (Am)2 + (Af)2 + (sAm)2 + (sAf)2] | *Rate at which adult female ranges overlap other groups:*Af[(βAm) + (βAf) + (βsAm) + (βsAf) + (βI)]2 |  Af1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MM | 0 | *Rate at which adult female ranges overlap other groups:*Af[(βAm) + (βAf) + (βsAm) + (βsAf) + (βI)]2 | *Territorial and infant defense:* Af βFIGHT [(Am)2 + (Af)2 + (sAm)2 + (sAf)2] | *Rate at which adult female ranges overlap other groups:*Af[(βAm) + (βAf) + (βsAm) + (βsAf) + (βI)]2 |  Af1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| UM | 0 | *Rate at which adult female ranges overlap other groups:*Af[(βAm) + (βAf) + (βsAm) + (βsAf) + (βI)]2 | *Territorial and infant defense:* Af βFIGHT [(Am)2 + (Af)2 + (sAm)2 + (sAf)2] | *Rate at which adult female ranges overlap other groups:*Af[(βAm) + (βAf) + (βsAm) + (βsAf) + (βI)]2 |  Af1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MO | 0a | *Rate at which adult female joins with new partners:* Af[(βAm)]2 | *Territorial and infant defense:* Af βFIGHT [(Am)2 + (Af)2] | *Rate at which adult female joins with new partners:* Af[(βAm)]2 |  Af1Δ[(βvAm) + (βvAf) + (βvI)]2 |
| SO | 0a | *Rate at which adult female joins with new partners:* Af[(βAm)]2 | *Territorial and infant defense:* Af βFIGHT [(Am)2 + (Af)2] | *Rate at which adult female joins with new partners:* Af[(βAm)]2 |  Af1Δ[(βvAm) + (βvAf) + (βvI)]2 |

a *Except for serial monogamy* **10. Adult Male Intergroup Transmission Possibilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | STI | Fecal Oral | Aggression/Grooming  | Aerosol | Vector |
| FF*(Bonobos)* | 0 | *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βsAm)1,2 + (βsAf)1,2 + (βI)1,2] | *Territorial defense:* Am βFIGHT [(Am)2 + (Af)2 + (sAm)2 + (sAf)2] | *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βsAm)1,2 + (βsAf)1,2 + (βI)1,2] |  Am1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MM | 0 | *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βsAm)1,2 + (βsAf)1,2 + (βI)1,2] | *Territorial defense:* Am βFIGHT [(Am)2 + (Af)2 + (sAm)2 + (sAf)2] |  *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βsAm)1,2 + (βsAf)1,2 + (βI)1,2] |  Am1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| UM | 0 | *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βsAm)1,2 + (βsAf)1,2 + (βI)1,2] | *Territorial defense:* Am βFIGHT [(Am)2 + (Af)2 + (sAm)2 + (Af)2] |  *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βsAm)1,2 + (βsAf)1,2 + (βI)1,2] |  Am1Δ[(βvAm) + (βvAf) + (βvsAm) + (βvsAf)+ (βvI)]2 |
| MO | 0a | *Rate at which adult male joins with new partners:* Am[(βAm)1,2 + (βAf)1,2 + (βI)1,2] | *Territorial defense:* Am βFIGHT [(Am)2 + (Af)2] |  *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βI)1,2] |  Am1Δ[(βvAm) + (βvAf) + (βvI)]2 |
| SO | bAm(βAf)n | *Rate at which adult male joins with new partners:*Am[(βAm)1,2 + (βAf)1,2 + (βI)1,2] | *Territorial defense:* Am βFIGHT [(Am)2 + (Af)2] |  *Rate at which adult male ranges overlap other groups:* Am[(βAm)1,2 + (βAf)1,2 + (βI)1,2] |  Am1Δ[(βvAm) + (βvAf) + (βvI)]2 |

*a Except for serial monogamy*

*b Serial sexual acts in n different groups*