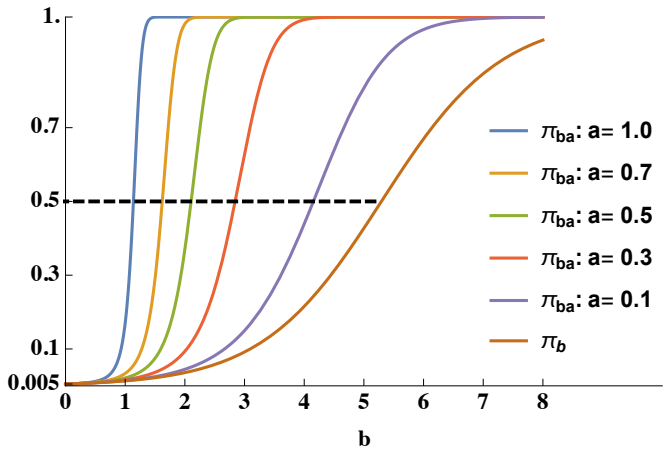
Figures from KPAGL paper

Comparison of the posterior probabilities of a second action potential for various levels of apical input, together with the posterior probability of an initiating action potential.

Fig. 2

```
post1[b_, a_]:= 1/(1+ Exp[5.2933 -0.5*b*(1 +Exp[0.5*b*a*(1+Exp[a])])])

Plot[{post1[b, 1.0], post1[b, 0.7], post1[b, 0.5], post1[b, 0.3], post1[b, 0.1], post1[b, 0]},
{b, 0, 8},  FrameTicks→{{0, 1, 2, 3, 4, 5, 6, 7, 8}, {0.005, 0.1, 0.3, 0.5, 0.7, 1.0}},
Frame→{{True, False}, {True, False}}, FrameLabel→{{"", None}, { "b", None}},
LabelStyle→{12,  Black}, TicksStyle→Directive[10], PlotRange→{{0,10},{0,1}},
Epilog→{Directive[{Thick,Dashed}],Line[{{-0.1, 0.5}, {5.3, 0.5}}]},
PlotLegends→Placed[{ "πba: a= 1.0","πba: a= 0.7", "πba: a= 0.5", "πba: a= 0.3",
"πba: a= 0.1" , "πb"}, {0.85,0.4}]]
```



Binarised data based on Shai et al. (2015)

A plot of the binary data that is read from the file *spbin.csv*, which was created in the R script, Figures1.R. The thresholds which were found using penalised logistic regression are superimposed on the plot.

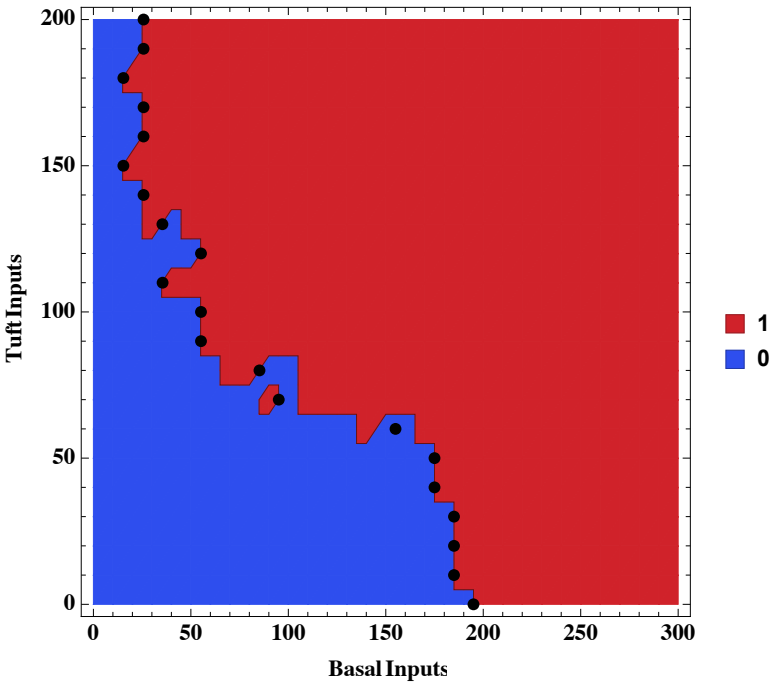
Fig. 3(a)

```
bindat = Import[ "/Users/jk/Desktop/KPAGL/spbin.csv"];
threshdat = Import[ "/Users/jk/Desktop/KPAGL/threshdat.csv"];

g1 = ListContourPlot[bindat, DataRange→{{ 0, 300}, { 0, 200}},
 ColorFunction→ ColorData["TemperatureMap"],Contours→1,
FrameLabel→{"Basal Inputs", "Tuft Inputs"}, LabelStyle→{12, Black},
PlotLegends→SwatchLegend[{ ColorData["TemperatureMap",1],
ColorData["TemperatureMap",0]}, {"1", "0"}]];

g2 = ListPlot[threshdat, FrameLabel→{"Basal Inputs", "Tuft Inputs"}, LabelStyle→{12, Black},
FrameLabel→{"Basal Inputs", "Tuft Inputs"}, PlotStyle→{Thick, Black}, AspectRatio→1];

Show[g1, g2]
```



The prediction thresholds plus pointwise 95% prediction limits, together with the number of apical tuft inputs are produced using the posterior predictive Bayesian analysis in Figures1.R. They are saved in the data matrix in the file pred.csv. Columns 3, 4, 5 contain the lower limit, the prediction and the upper limit, respectively. Column 2 contains the number of Tuft inputs.

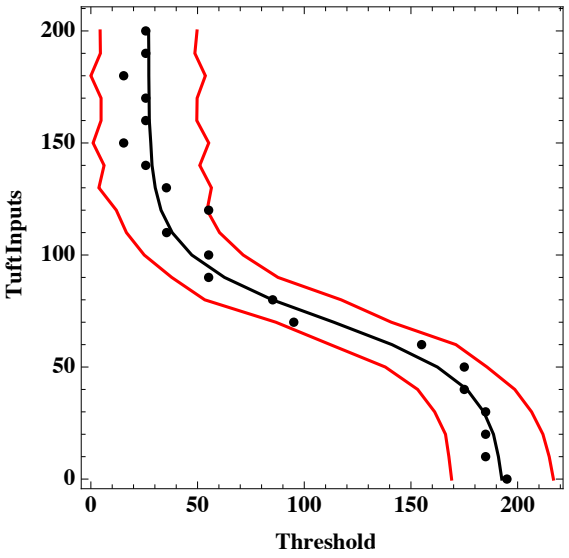
Graph g2 from Fig. 3(a) is also used here.

Fig. 3(b)

```
pred = Import[ "/Users/jk/Desktop/KPAGL/pred.csv"];

g3=ListLinePlot[{pred[[All,{3,2}]],pred[[All,{4,2}]], pred[[All,{5,2}]]}, PlotStyle→{Red, Black, Red},
DataRange→{{-1, 220},{ -1, 201}}, PlotRange→All, AxesLabel→{"Threshold", "Tuft Inputs"},
LabelStyle→{12, Black}, FrameLabel→{ "Threshold", "Tuft Inputs"}, Frame→ True, AspectRatio→1];

Show[g3, g2]
```



Threshold model for binarised data based on Shai et al. (2015)

Region, contour and surface plots of the posterior predictive probability of a second action potential for given values of the basal and apical inputs are given below. The posterior predictive probabilities were computed on a 21 by 31 grid in the R script Figures1.R, and were saved to the file TMdat.csv. We first import the data.

```
TMdat = Import["/Users/jk/Desktop/KPAGL/TMdat.csv"];
```

Fig. 4(a)

```
ListContourPlot[TMdat, ColorFunction → ColorData["TemperatureMap"],
 FrameLabel → {"Basal Inputs", "Tuft Inputs"}, LabelStyle → {12, Black},
Contours → {0.5}, ContourStyle → {RGBColor[0, 0, 0], AbsoluteThickness[5]}]
```

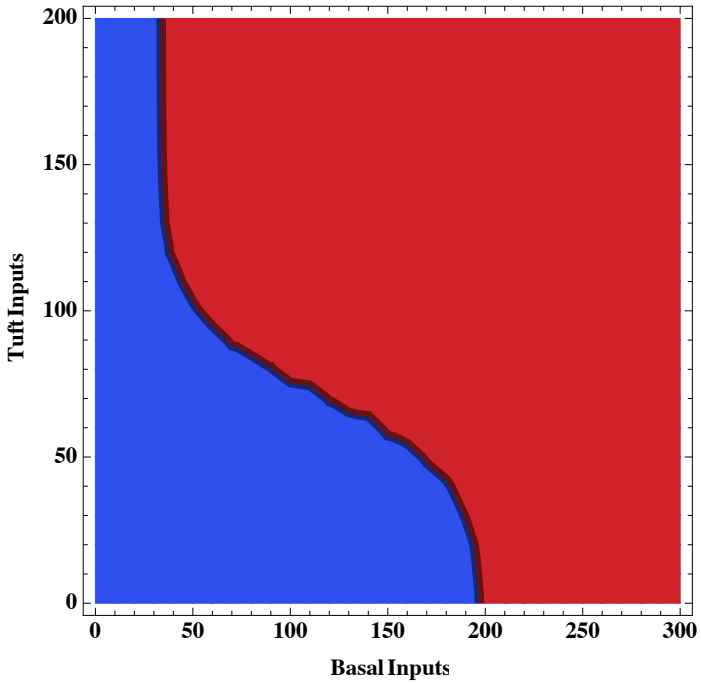


Fig 4(c)

```
ListContourPlot[TMdat,
 ColorFunction → ColorData["TemperatureMap"], Contours → 10,
 FrameLabel → {"Basal Inputs", "Tuft Inputs"}, LabelStyle → {12, Bold, Black},
 PlotLegends → BarLegend[{Automatic, {0, 1}}, {Automatic, 10}]]
```

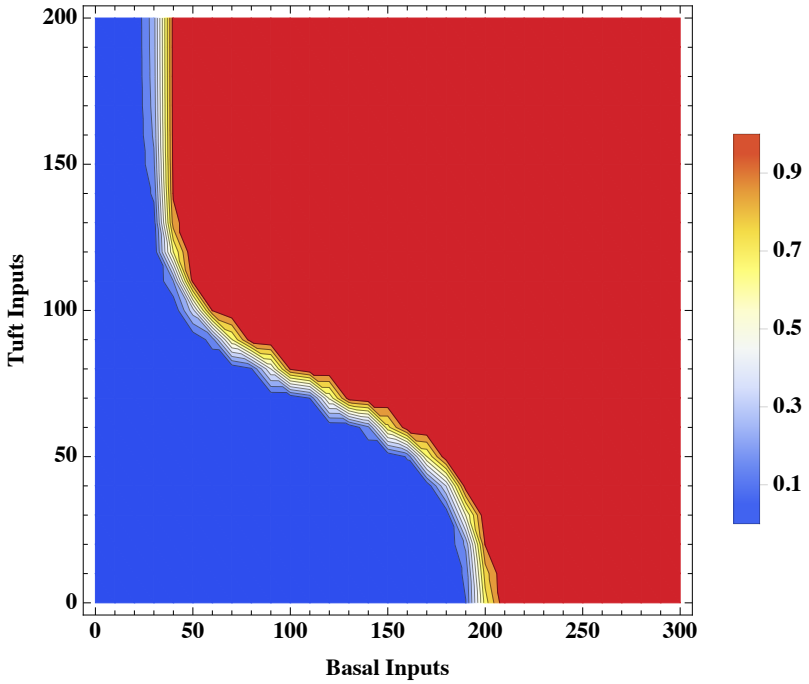
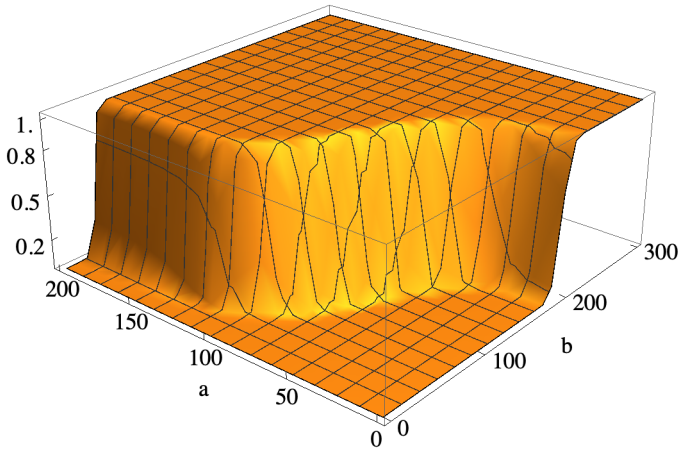


Fig. 4(e)

```
ListPlot3D[TMdat, AxesLabel → {"b", "a", " "}, LabelStyle → {12, Black}, TicksStyle → Directive[12
  ], Ticks → {{0, 100, 200, 300}, {0, 50, 100, 150, 200}, { 0.2, 0.5, 0.8, 1.0}}, PlotRange -> {0, 1.05}]
```



General model for binarised data based on Shai et al. (2015)

Region, contour and surface plots of the posterior predictive probability of a second action potential for given values of the basal and apical inputs are given below. The posterior predictive probabilities were computed on a 21 by 31 grid in the R script Figures1.R, and were saved to the file GMdat.csv. We first import the data.

```
GMdat = Import["/Users/jk/Desktop/KPAGL/GMdat.csv"];
```

Fig. 4(b)

```
ListContourPlot[GMdat,
 ColorFunction → ColorData["TemperatureMap"],
 Contours → {0.5}, ContourStyle → Directive[Black, AbsoluteThickness[5]],
 FrameLabel → {"Basal Inputs", "Tuft Inputs"}, LabelStyle → {12, Black}]
```

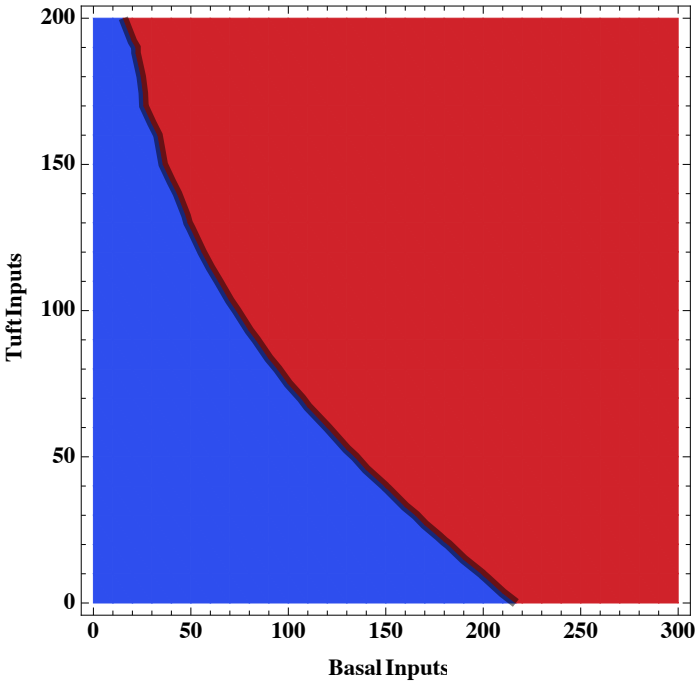


Fig. 4(d)

```
ListContourPlot[GMdat, Contours → 10,
 ColorFunction → ColorData["TemperatureMap"], FrameLabel → {"Basal Inputs", "Tuft Inputs"},
 LabelStyle → {12, Black}, PlotLegends → BarLegend[{Automatic, {0, 1}}, {Automatic, 10}]]
```

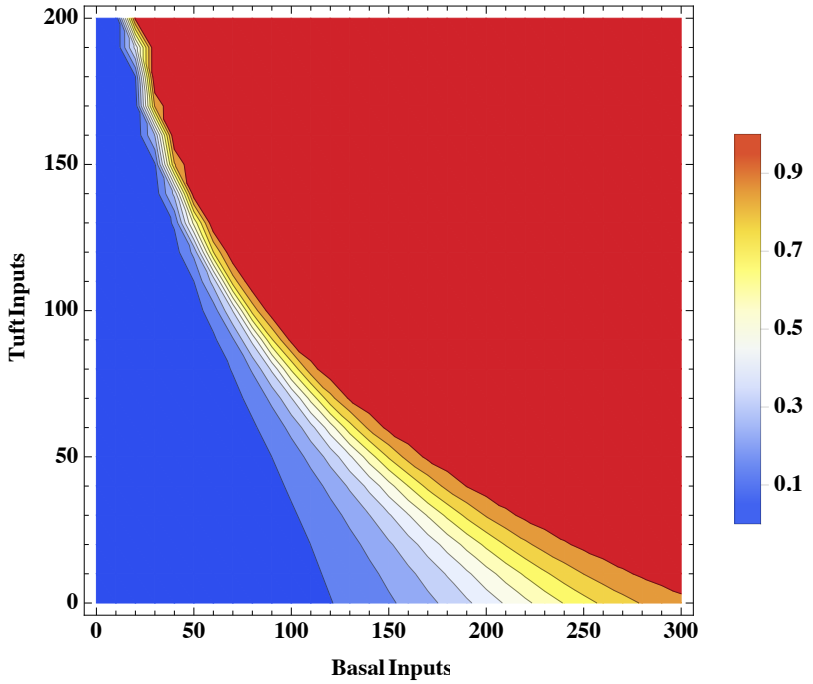
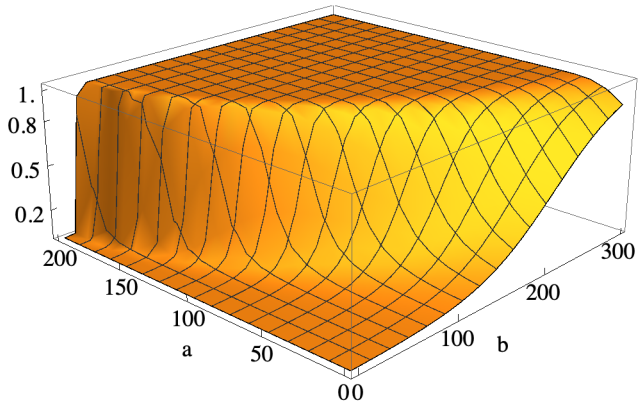


Fig 4(f)

```
ListPlot3D[GMdat, AxesLabel → {"b", "a", " "}, LabelStyle → {12, Black}, TicksStyle → Directive[12],
 Ticks → {{0, 100, 200, 300}, {0, 50, 100, 150, 200}, { 0.2, 0.5, 0.8, 1.0}}, PlotRange -> {0, 1.05}]
```



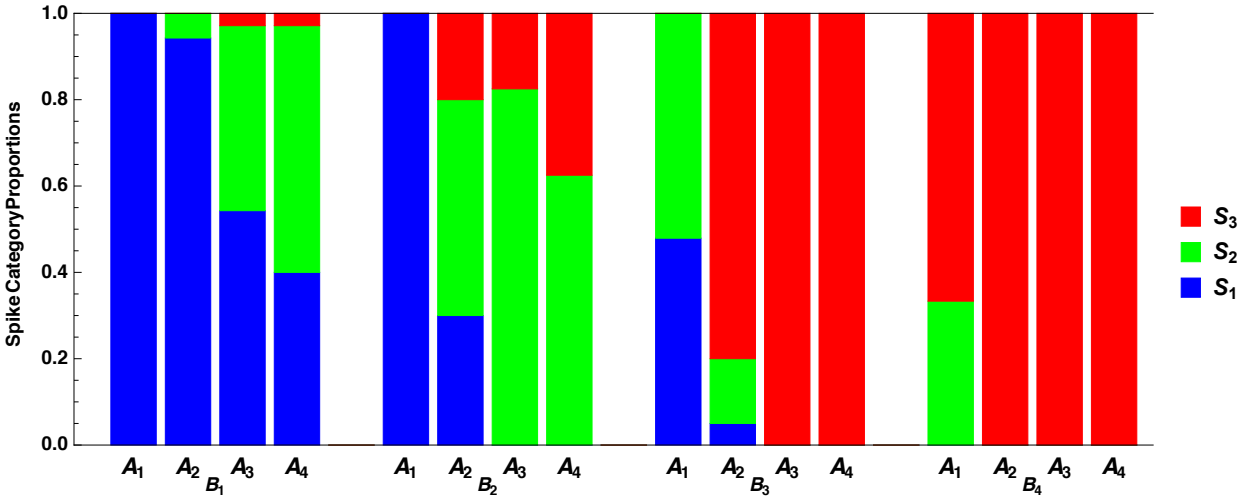
Categorised data based on Shai et al. (2015)

Bar Chart of the categorised action potential data from Figures3.R.

Fig. 5

```
data=N[{{1,0,0},{33,2,0}/35,{19,15,1}/35,{14,20,1}/35,{0,0,0},{1,0,0},{12,20,8}/40,
{0, 33, 7}/40,{0, 25, 15}/40,{0,0,0},{23,25,0}/48,{2,6,32}/40,{0,0,1},{0,0,1},{0,0,0},
{0, 16, 32}/48,{0,0, 1},{0, 0, 1},{0, 0, 1}}];

BarChart[data,AspectRatio→0.4,BaseStyle→Directive[FontFamily→"Helvetica",10,GrayLevel[0.6]],
BarSpacing→0.2,ChartBaseStyle→Directive[EdgeForm[], Black],ChartLayout→"Stacked",
LabelStyle→{Black},ChartLabels→{Placed[Style[#,12]&/@{"A1", "A2", "A3", "A4", "
", "A1", "A2", "A3", "A4", " ","A1", "A2", "A3", "A4", " ","A1", "A2", "A3", "A4", " "},Below],
None},ChartStyle→{Blue, Green, Red},Frame→{{True,False},{True,True}},
FrameLabel→{None,Style["Spike Category Proportions",Black],None,None},
FrameStyle→Black,FrameTicksStyle→Black,GridLinesStyle→GrayLevel[0.7],
ImageSize→600,PlotRangePadding→{{0.3,0.3},{0,0}},Ticks→{None,Automatic},
ChartLegends→{"S1", "S2", "S3"}, FrameTicks->{{{2.5,"\nB1",0},{7.5,"\nB2",0},{12.5,"\nB3",0},
{17.5,"\nB4",0}},Automatic,None,None}]
```



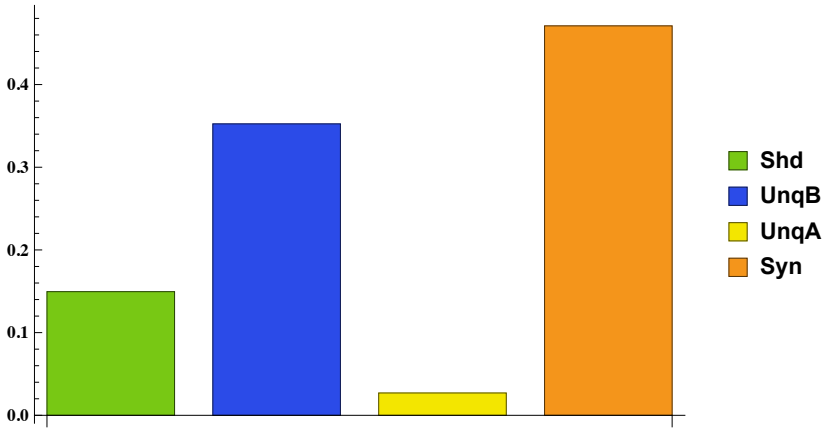
Partial Information Decomposition

PID of the categorised system of action potential data based on Shai et al. (2015).

Fig. 6

```
mycol={  RGBColor[120/255, 200/255, 20/255], RGBColor[43/255, 75/255, 232/255],
RGBColor[243/255, 230/255, 0], RGBColor[244/255, 149/255, 27/255] };
pid ={0.1510, 0.3559, 0.0273, 0.4756}; pid = pid/Total[pid];
myleg = { "Shd", "UnqB","UnqA","Syn"};

BarChart[pid, ChartStyle→mycol, BarSpacing → { 0.3}, LabelStyle→{Black, Bold},
ChartLegends→ myleg, ChartLabels→{Placed[Style[#,12, Bold]&/@{"Shd", "UnqB", "UnqA", "Syn"},
Below], None}]
```

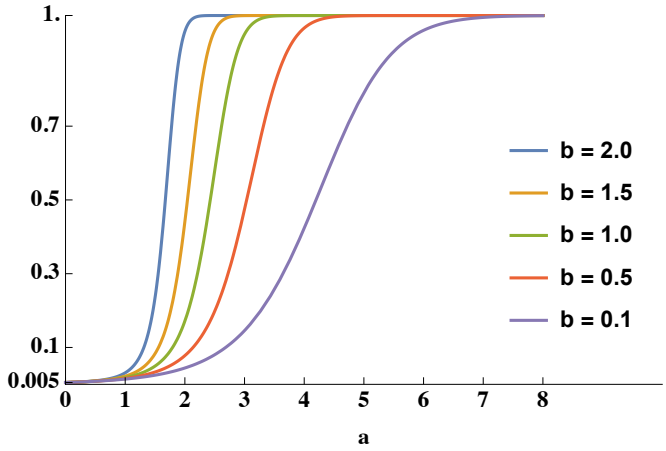


Comparison of posterior probabilities of an action potential for various levels of basal input when the apical input is driving, without an initiating backpropagated action potential having been generated.

Fig. 7(a)

```
post2[b_, a_]:= 1/(1+ Exp[5.2933 -0.5*a*(1 +Exp[b*a])])

Plot[{post2[1.0, a], post2[0.7, a], post2[0.5, a], post2[0.3, a], post2[0.1, a]},
{a, 0, 8},  FrameTicks→{{0, 1, 2, 3, 4, 5, 6, 7, 8}, {0.005, 0.1, 0.3, 0.5, 0.7, 1.0}},
Frame→{{True, False}, {True, False}}, FrameLabel→{{"", None}, { "a", None}},
LabelStyle→{12, Bold, Black}, TicksStyle→Directive[Bold, 10], PlotRange→{{0,10},{0,1}},
PlotLegends→Placed[{ "b = 2.0","b = 1.5", "b = 1.0", "b = 0.5",
"b = 0.1" }, {0.85,0.4}]]
```

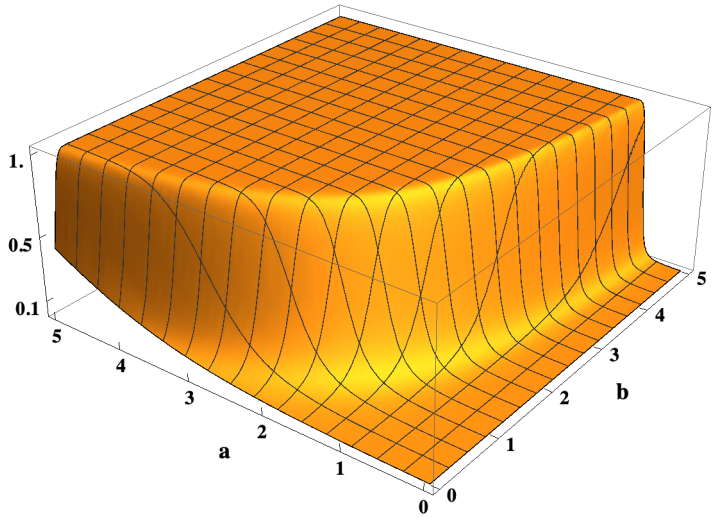


Surface of the posterior probability of an action potential as a function of the levels of basal and apical inputs, using Eqs (31, 32). Here the drive is from the apical input, without an initiating backpropagated action potential having been generated.

Fig7(b)

```
act5[b_, a_] := -5.2933 + 0.5 * a * (1 + Exp[b * a]); t = 10.0;
act6[b_, a_] := If[act5[b, a] > t, t, act5[b, a]];
surf2[b_, a_] := 1 / (1 + Exp[-act6[b, a]]);

Plot3D[surf2[b, a], {b, 0, 5}, {a, 0, 5}, AxesLabel → {"b", "a", " "}, LabelStyle → {12, Bold, Black},
TicksStyle → Directive[Bold, 10], Ticks → {{0, 1, 2, 3, 4, 5}, {0, 1, 2, 3, 4, 5}, {0.1, 0.5, 1.0}},
PlotPoints → 50, PlotRange -> {0, 1.05}]
```

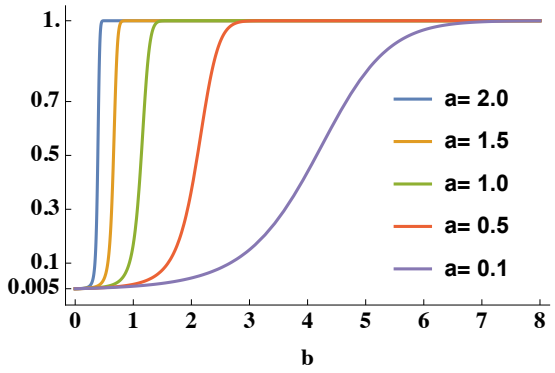


Comparison of posterior probabilities of an action potential for various levels of apical input when the apical input is driving, without an initiating backpropagated action potential having been generated.

Fig. 7(c)

```
   wt3[b_, a_]:= -5.2933 + 0.5*b*(1 +Exp[0.5*b*a*(1+Exp[a])]); t=10.0;
   wt4[b_, a_]:= If[wt3[b,a]>t, t, wt3[b,a]];
   post2[b_, a_]:= 1/(1 + Exp[-wt4[b,a]]);

Plot[{post2[b, 2.0], post2[b, 1.5], post2[b, 1.0], post2[b, 0.5], post2[b, 0.1]},
{b, 0, 8},  FrameTicks→{{0, 1, 2, 3, 4, 5, 6, 7, 8}, {0.005, 0.1, 0.3, 0.5, 0.7, 1.0}},
Frame→{{True, False}, {True, False}}, FrameLabel→{{"", None}, { "b", None}},
LabelStyle→{12, Bold, Black}, TicksStyle→Directive[Bold, 10],
PlotLegends→Placed[{ "a= 2.0","a= 1.5", "a= 1.0", "a= 0.5",
"a= 0.1" }, {0.8,0.4}]]
```

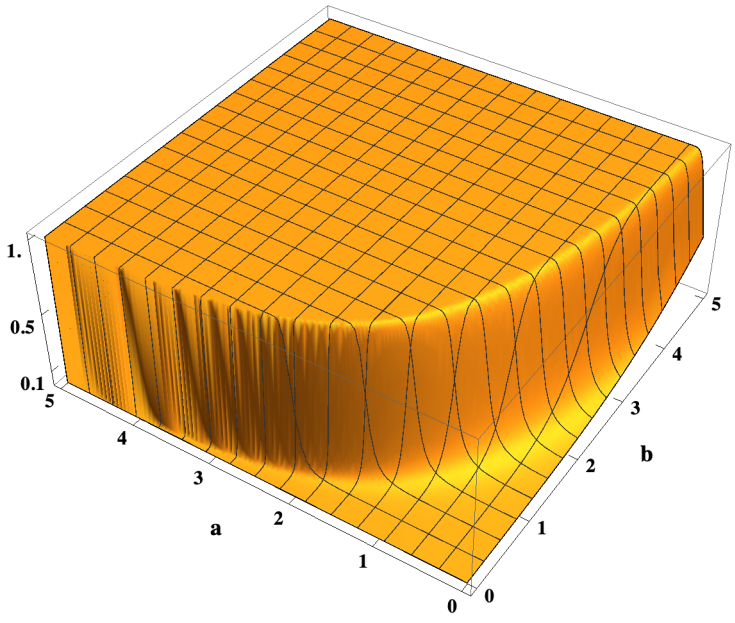


Surface of the posterior probability of a second action potential as a function of the levels of basal and apical inputs, using Eqs (7, 8). Here an initiating backpropagated action potential has been generated and BAC firing triggered, and the initial drive comes from the basal input.

Fig 7(d)

```
act3[b_, a_] := -5.2933 + 0.5 * b * (1 + Exp[0.5 * b * a * (1 + Exp[a])]); t = 10.0;
act4[b_, a_] := If[act3[b, a] > t, t, act3[b, a]];
surf1[b_, a_] := 1 / (1 + Exp[-act4[b, a]]);

Plot3D[surf1[b, a], {b, 0, 5}, {a, 0, 5}, AxesLabel → {"b", "a", " "}, LabelStyle → {12, Bold, Black},
TicksStyle → Directive[Bold, 10], Ticks → {{0, 1, 2, 3, 4, 5}, {0, 1, 2, 3, 4, 5}, {0.1, 0.5, 1.0}},
PlotPoints → 50, PlotRange -> {0, 1.05}]
```

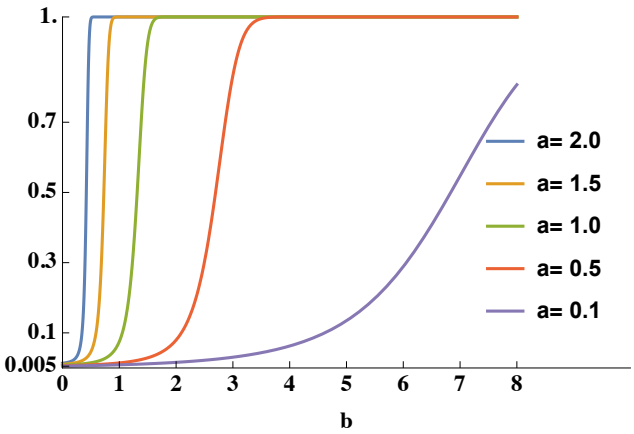


Comparison of posterior probabilities of an action potential for various levels of apical input, in the scenario where amplification results from a mixture of basal and apical inputs, using Eq (33)

Fig. 8(a)

```
act8[b_, a_]:= -5.2933 + 0.25*b*(1 + Exp[0.5*b*a*(1 +Exp[a])]) +0.25*a*(1+Exp[b*a]);
t=10.0;
act9[b_,a_]:= If[ act8[b, a]>t, t, act8[b,a]];
post3[b_, a_]:= 1/(1+ Exp[-act9[b, a]]);

Plot[{post3[b, 2.0], post3[b, 1.5], post3[b, 1.0], post3[b, 0.5], post3[b, 0.1]},
{b, 0, 8},  FrameTicks→{{0, 1, 2, 3, 4, 5, 6, 7, 8}, {0.005, 0.1, 0.3, 0.5, 0.7, 1.0}},
Frame→{{True, False}, {True, False}}, FrameLabel→{{"", None}, { "b", None}},
LabelStyle→{12, Bold, Black}, TicksStyle→Directive[Bold, 10], PlotRange→{{0,10},{0,1}},
PlotLegends→Placed[{ "a= 2.0","a= 1.5", "a= 1.0", "a= 0.5",
"a= 0.1" }, {0.85,0.4}]]
```

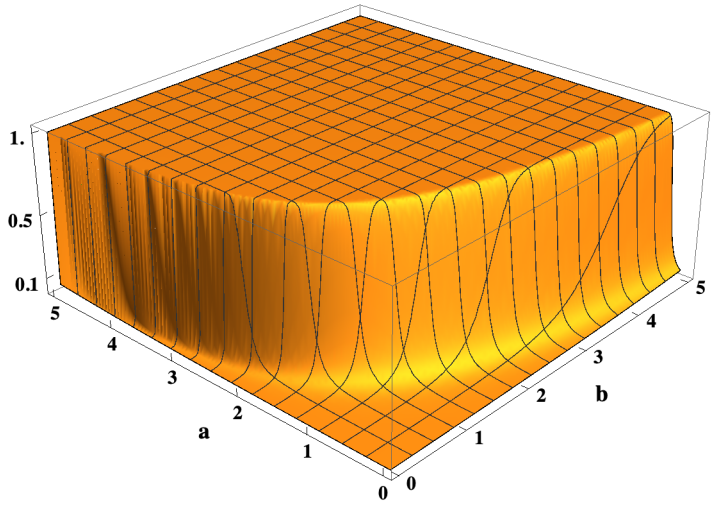


Surface of posterior probability of an action potential in the scenario where amplification results from a mixture of basal and apical inputs, using Eq (33)

Fig 8(b)

```
act10[b_, a_] := -5.2933 + 0.25 * b * (1 + Exp[0.5 * b * a * (1 + Exp[a])]) + 0.25 * a * (1 + Exp[b * a]);
act11[b_, a_] := If[act10[b, a] > t, t, act10[b, a]];
surf3[b_, a_] := 1 / (1 + Exp[-act11[b, a]]);

Plot3D[surf3[b, a], {b, 0, 5}, {a, 0, 5}, AxesLabel → {"b", "a", " "}, LabelStyle → {12, Bold, Black},
TicksStyle → Directive[Bold, 10], Ticks → {{0, 1, 2, 3, 4, 5}, {0, 1, 2, 3, 4, 5}, {0.1, 0.5, 1.0}},
PlotPoints → 50, PlotRange -> {0, 1.05}]
```

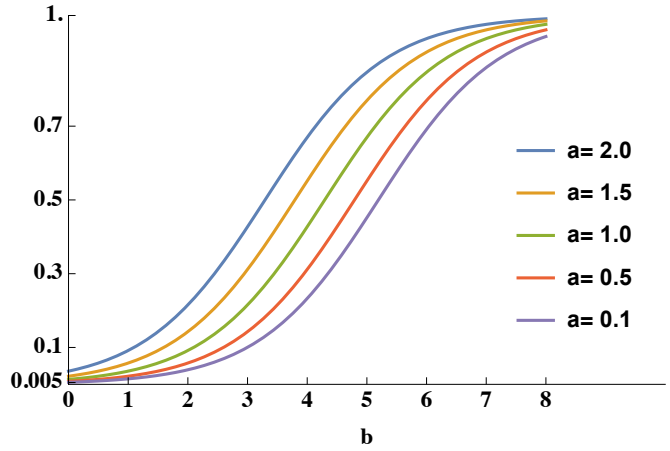


Comparison of posterior probabilities of an action potential for various levels of basal input, in the scenario where amplification results from an additive mixture of basal and apical inputs, using Eq (34)

Fig. 8(c)

```
post4[b_, a_]:= 1/(1+ Exp[5.2933 - a - b])

Plot[{post4[b, 2.0], post4[b, 1.5], post4[b, 1.0], post4[b, 0.5], post4[b, 0.1]},
{b, 0, 8},  FrameTicks→{{0, 1, 2, 3, 4, 5, 6, 7, 8}, {0.005, 0.1, 0.3, 0.5, 0.7, 1.0}},
Frame→{{True, False}, {True, False}}, FrameLabel→{{"", None}, { "b", None}},
LabelStyle→{12, Bold, Black}, TicksStyle→Directive[Bold, 10], PlotRange→{{0,10},{0,1}},
PlotLegends→Placed[{ "a= 2.0","a= 1.5", "a= 1.0", "a= 0.5",
"a= 0.1" }, {0.85,0.4}]]
```



Surface of posterior probability of an action potential in the scenario where amplification results from ad additive mixture of basal and apical inputs, as in Eq (34).

Fig 8(d)

```
act12[b_, a_] :=  -5.2933 + a + b;
surf4[b_, a_] := 1 / (1 + Exp[-act12[b, a]]);

Plot3D[surf4[b,  a], {b, 0, 5}, {a, 0, 5},  AxesLabel → {"b", "a", " "}, LabelStyle → {12, Bold, Black},
TicksStyle → Directive[Bold, 10], Ticks → {{0, 1, 2, 3, 4, 5}, {0, 1, 2, 3, 4, 5}, { 0.1, 0.5, 1.0}},
PlotPoints → 50, PlotRange -> {0, 1.05}]
```