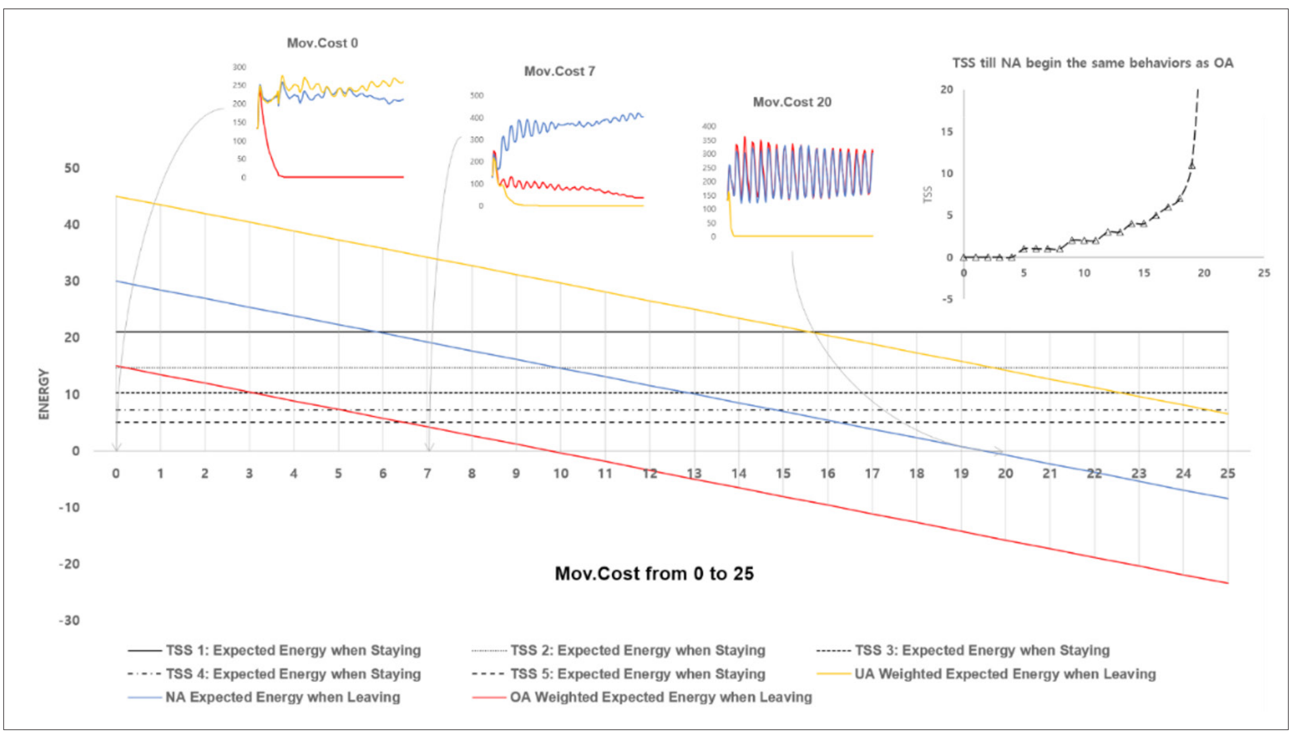
SUPPLEMENT MATERIALS

Calibration of Main Parameters

Movement Cost

Circle compares R available in the current patch (R.D.R. × R) with R of the entire habitat (M.R.D.R. × R0). If Mov.Cost is zero; the circle will move immediately when the latter exceeds the former. If Mov.Cost is huge; the circle never moves. All circles will die soon.

What happens if the circle stays? As TSS increases, obtainable E decreases. Therefore, as the TSS increases, the circle will consider movement. UA moves first, NA moves next. OA moves most late. Suppose that Env.Ht. is 0, R0 is 100, R.O.P. is 0.4, and R.D.R. and M.R.D.R. are 0.3. These figures are obtained by experiments of several hundred times. The expected E acquisition of the moving circle and the expected E acquisition of the staying circle are shown in Supplementary Figure 1. UA, NA, and OA are shown in orange, blue, and red, respectively (the designated colours are the same throughout the paper). The expected E acquisition of the staying circles is indicated by different kinds of black lines. When TSS is increased, the expected E for staying circles decreases gradually.



Supplementary Figure 1. Weighted expected energy from the new patch.

The three small graphs above show the population of each circle over time when Mov.Cost is 0, 7, and 20, respectively (Note that the circles move freely here, and the patch's R are randomly distributed). As seen in the chart, if Mov.Cost is 0, the fitness of UA and NA is the same. If Mov.Cost is 20, the fitness of NA and OA is the same.

When Mov.Cost is 7, it gets a bit complicated. When TSS is 1, the behavioural pattern of OA and NA is the same. OA and NA stay, but UA moves. If TSS is 2 or more, the behaviour of UA and NA becomes the same.NA decides to leave. If Mov.Cost is going up, UA becomes more watchful than before. If Mov.Cost is beyond 16, UA starts to stay on TSS 1. The small graph on the right above shows the TSS until NA shows the same behaviour as OA according to Mov.Cost.

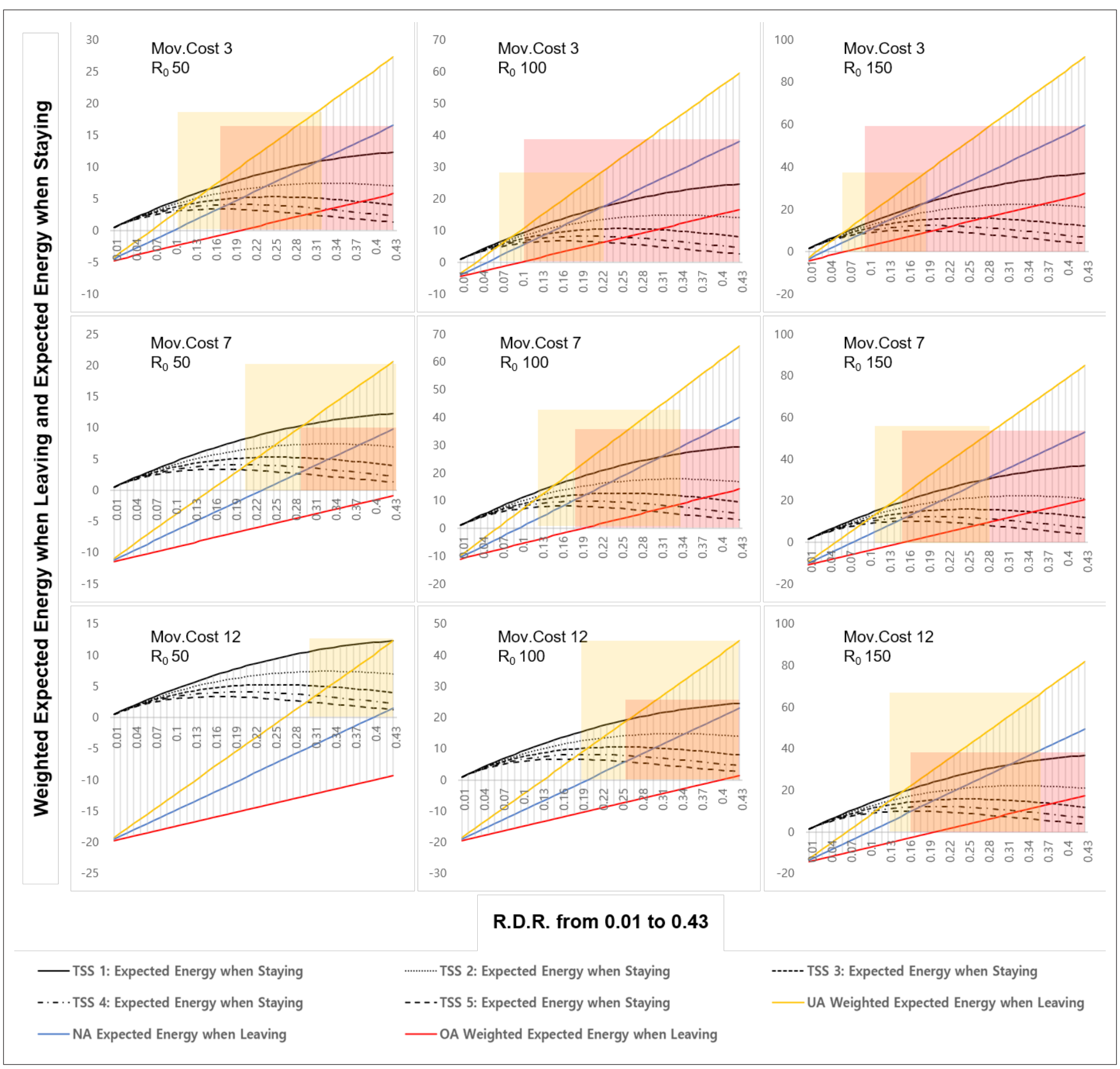
As the TSS increases, (R.D.R. × R) converges to 0. However, weighted expected E of UA, NA, and OA shows a monotonic decreasing function. So, if Mov.Cost exceeds 30, 20, and 10, weighted expected E shows a negative value. Therefore, if Mov.Cost exceeds these values, the circle will not move in any case. However, since Mnt.Cost must be considered, the TSS cannot be infinitely increased. If Mov.Cost is excessively high, all circles will die in the order of OA, NA, UA. Therefore, the value of Mov.Cost, which is appropriate for the simulation environment, should be between 4 to 20. If R.D.R. is 0.3, it should be between 6 and 20, and if it is 0.4, it should be between 10 and 20. Practically, TSS cannot be increased infinitely. If the maximum value of the TSS is regarded as about 5, it should be between 3 and 14 when R.D.R. is 0.2, and between 6 and 14 when R.D.R. is 0.2

R.D.R.

When the average R0 is 100 and Env.Ht. is 1, the R0 of each patch is distributed as a linear distribution between 0 and 200. If Env.Ht. is set to 25, then each R0 is distributed as a linear distribution between 75 and 125. Under resource-poor patches, the circle should leave the patch more rapidly. Under resource-rich patches, the circle should leave the patch more slowly. Therefore, in a habitat showing environmental heterogeneity, the circles exhibit different TSS depending on the amount of each patch's resources.

R.D.R. calibration is tricky, because the expected E acquisition are differed from moving and staying circles according to the change of R.D.R.

The following assumptions were made. Mov.Cost is assumed to be 3, 7, and 12, and R0 is 50, 100, and 150. Then, the expected E acquisition according to R.D.R. is calculated for leaving and staying. The results are shown in the following chart (Supplementary Figure 2). The red window represents the range of changes in the behaviour of OA and NA throughout 5 TSSs. The yellow window represents the range in which the behavioural tendency s of UA and NA change throughout five TSSs (Note: in some graphs the full range of red and yellow windows is not visible).



Supplementary Figure 2. Weighted expected energy when leaving.

Supplementary Table 1. Range of yellow window and red window according to each Mov.Cost and R_0 value

Mov.Cost	Yellow window			Red window		
	R_0	Low limit	Upper limit	Low limit*	Low limit**	Upper limit
3	50	0.11	0.31	0.1	0.17	0.65
	100	0.07	0.22	0.05	0.12	0.58
	150	0.05	0.18	0.04	0.09	0.55
7	50	0.2	0.48	0.24	0.29	0.79
	100	0.12	0.34	0.12	0.17	0.67
	150	0.09	0.27	0.08	0.15	0.62
12	50	0.31	0.63	0.4	0.43	0.93
	100	0.28	0.44	0.2	0.26	0.76
	150	0.14	0.36	0.14	0.2	0.69

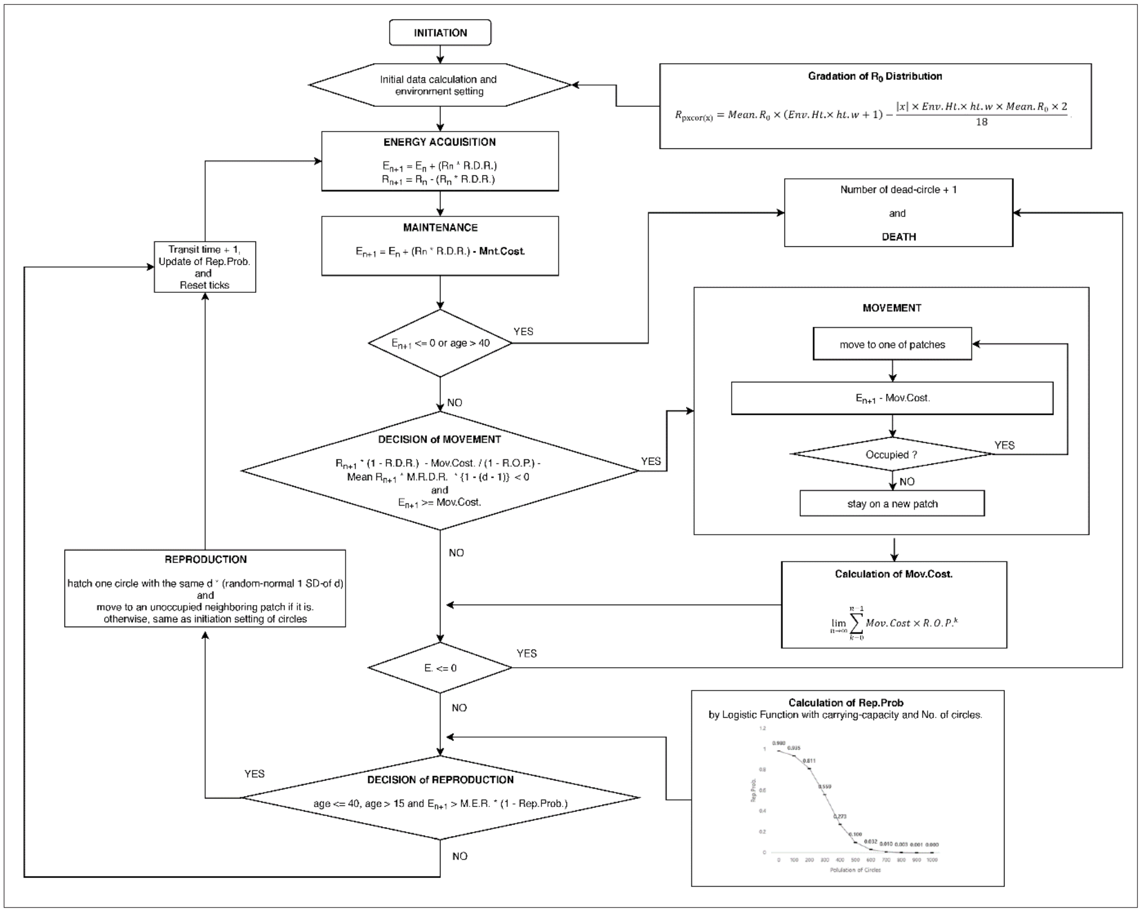
*until Expected Energy when leaving go down below 0, **until TSS is 5

Suppose TSS is a maximum of 5. If Mov.Cost is 3 and R0 is 50 and RDR is more than 0.17, OA and NA behave differently in TSS 5. The same behaviour (staying) is seen when the RDR is less than 0.16. This pattern remains the same until the RDR is 0.65. If the RDR exceeds 0.66, OA and NA show the same behaviour (leaving). It is indicated by a red window. If the TSS diverges beyond 5 and infinitely, the lower limit is lowered until the expected E acquisition is zero, which is 0.24.

The graph shows only RDRs up to 0.43, so some segments are not shown. On the other hand, if RDR is 0.11 or more, EA and NA behave differently in TSS 5. When it is less than 0.10, the same behaviour (staying) is shown. This tendency is the same until the RDR is 0.31. If RDR exceeds 0.32, UA and NA will show the same behaviour (leaving) again. This is indicated by a yellow window. The following Supplementary Table 1 summarises the ranges of red and yellow windows for all nine cases.

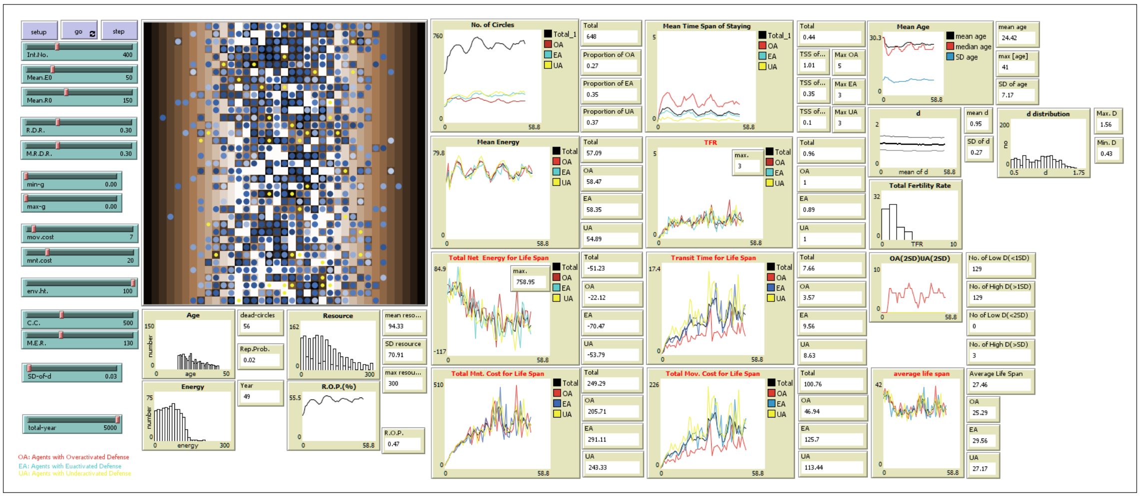
Taken together, if Mov.Cost is 7 and R0 is uniformly distributed between 50 and 150, the most suitable RDR should be located between 0.24 and 0.27. Since the TSS is unlikely to emerge infinitely, the largest value of 0.27 in the above range can be regarded as the most suitable RDR value. However, it is assumed that the ROP is 0.4. As the ROP increases, each window moves up. Also, as the average R increases, each window also moves down. Also, as Env.Ht. becomes higher, the width of R0 becomes more extensive, so that the interval in which there is no proper RDR value corresponding to the R of different patches becomes longer. Overall, in an environment where Mov.Cost is 7 and R0 is 100, the value between 0.17 and 0.34 where the red window (assuming TSS max is 5) and the yellow window overlaps, or the value between 0.24 and 0.27 mentioned above can be considered as the suitable RDR range for stable simulation experiments.

Schematic Diagram of Flow Chart (Supplementary Figure 3)

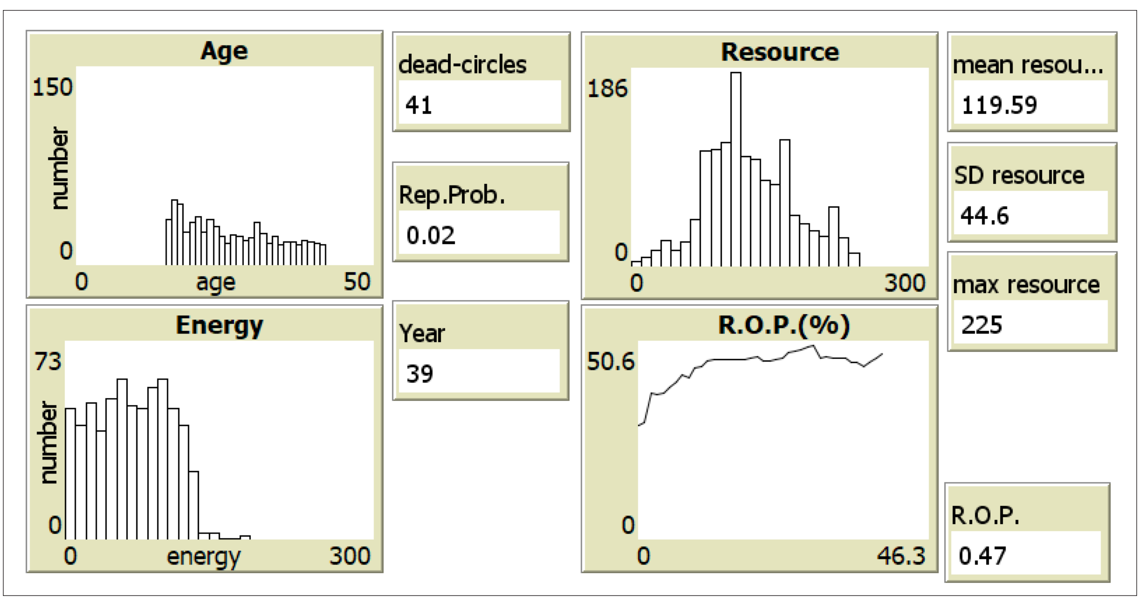


Supplementary Figure 3. Flow chart of defence activation disorder model.

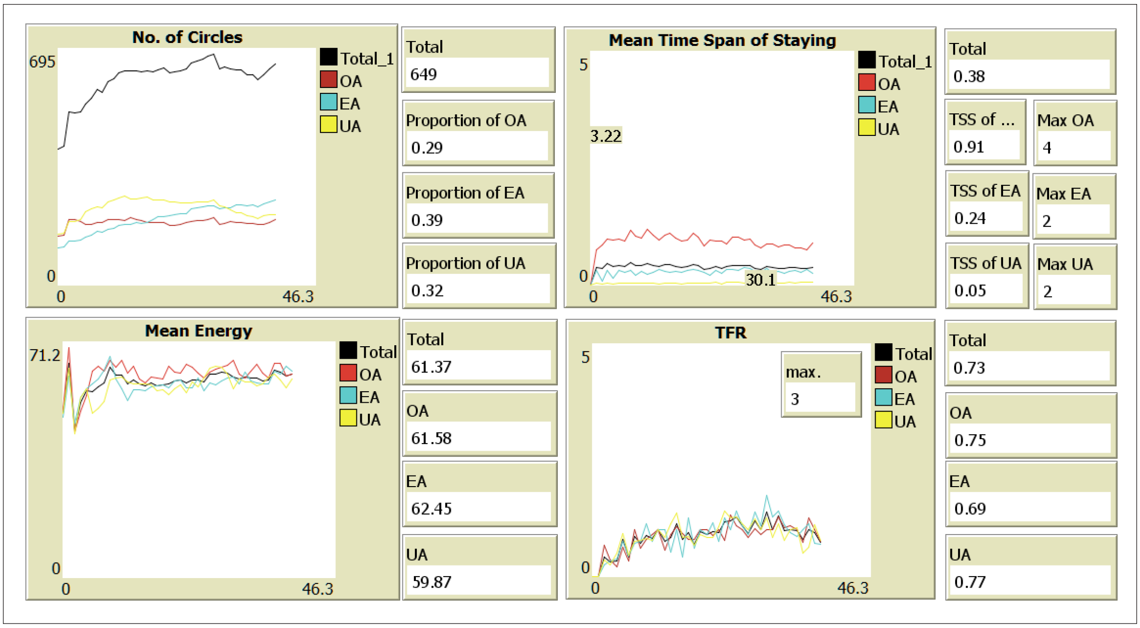
Display Interface of Simulation Model (Supplementary Figure 4)



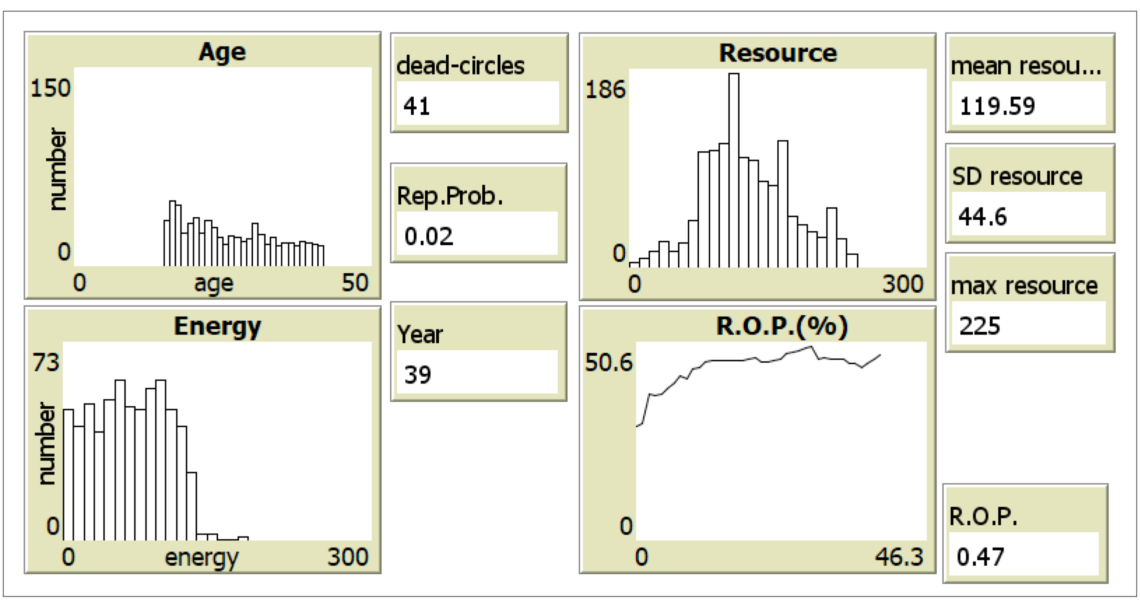
Supplementary Figure 4-1. Display interfaces of balancing selection model of defence activation disorder. The entire interface of the simulation model.



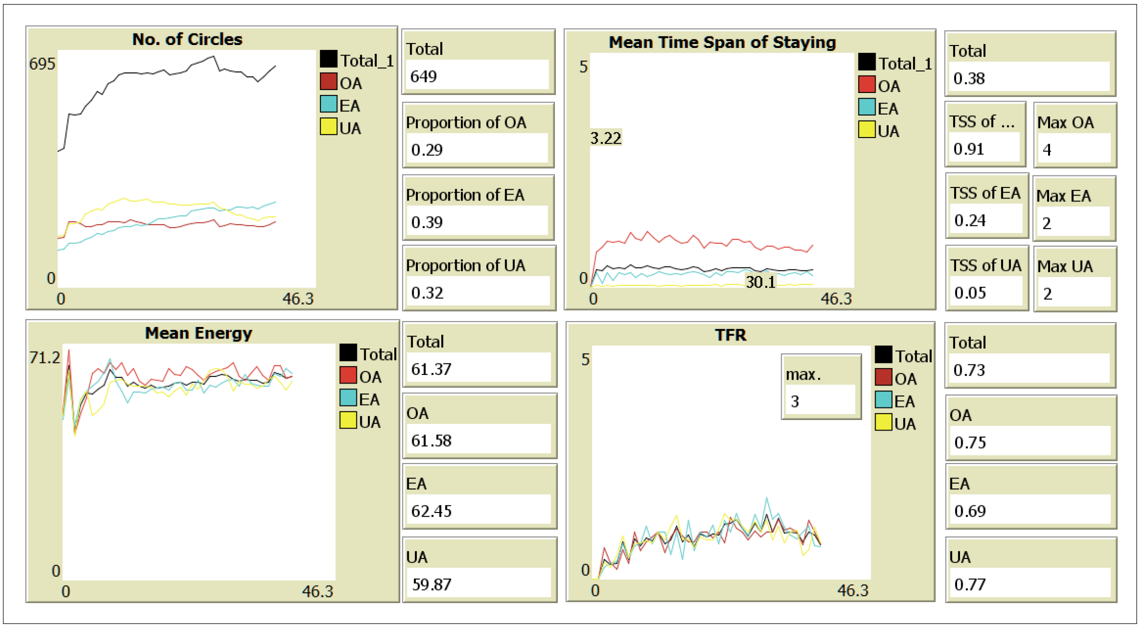
Supplementary Figure 4-2. Display interfaces of balancing selection model of defence activation disorder. Inspecting the Demography (Current Situation the Histogram windows of Age, Resource and Energy and the Plotting Window of R.O.P. with adjunct Monitoring Windows for Accumulated No. of Death, Rep.Prob, Year and so on).



Supplementary Figure 4-3. Display interfaces of balancing selection model of defence activation disorder. Inspecting the Current Situation (the Plotting Window of No. of Circles, Mean Time Span of Staying, Mean Energy and TFR with Adjunct Monitoring Windows for Inspecting the Current Situation).



Supplementary Figure 4-4. Display interfaces of balancing selection model of defence activation disorder. Inspecting the Accumlated Outcomes (the Plotting Window of Total Net Energy (Acquisition), Total TSS, Total Mnt.Cost, Total Mov.Cost For Lifespan with Adjunct Monitoring Windows).



Supplementary Figure 4-5. Display interfaces of balancing selection model of defence activation disorder. Inspecting d-value and Fitness of Agents (the Plotting Window of Mean Age, d-value, TFR, proportion of OA and UA and Life Expectancy with Adjunct Monitoring Windows).