# This is an R-based program for estimating yawn contagion recorded to the nearest tenth of a min.

# The program measures yawn contagion according to the suggestions made by Dr. Stephen E. G. Lea during the review process of a manuscript eventually published in *Animal Cognition*.

# yc () counts the rate of yawn contagion from "x " to "y " and vice versa using a k-min time window and l-min observation period.

# to run the program just copy the commands and paste them in the R console.

yc <- function(x,y,k,l) {

x <- x[!is.na(x)]; y <- y[!is.na(y)]

c1 <- 0; c2 <- NULL; c3 <- 0

tn <- 0

{

t1 <- ifelse(diff(y)>=k, (diff(y)-k), 0)

t2 <- ifelse(l-(y[length(y)])>k, l-(y[length(y)]+k), 0)

c1 <- c1+length(x[x >= y[1]-y[1] & x <= y[1]])

w <- which(diff(y)>=k)

for(i in w){

c2[i] <- length(x[x >= y[i]+k & x <= y[i+1]])

}

if(t2>0) c3 <- c3+length(x[x >= y[length(y)]+k & x <= l]) else c3 <- 0

tn <- tn+sum(y[1],t1,t2)

cn <- sum(c1,c2,c3 , na.rm=T)

tp <- l-tn

cp <- length(x)-cn

tb <- c(cn/tn,cp/tp)

}

print(tb)

}

# Example

# Consider the time series for two rats (“A” and “B”) that are observed during 12 min, and that you recorded the minute and decimal of minute at which each yawn occurred. Suppose also that a 3-min window was used to measure yawn contagion.

> A <- c(2.3,5.1,5.8,10.4,10.8,11.1,NA) # As the two sequences A and B should have the same length (i.e. 7), NA is used to fill in the empty spaces.

> B <- c(1.2,2.4,4.5,5.1,11.2,11.6,11.8)

> yc(A,B,3,12)

[1] 0.6976744 0.3896104

This means that Rat A yawned 0.69 of the time when the Rat B had not yawned within the relevant time window, whereas Rat A yawned 0.38 of the time when the Rat B had yawned within the relevant time window.

> yc(B,A,3,12)

[1] 0.2564103 0.7407407

This means that Rat B yawned 0.25 of the time when the Rat A had not yawned within the relevant time Windows, and 0.74 of the time when the Rat A had yawned within that time window.