Conclusion

In our project we want to tackle the question “Can responsiveness evolve and does this induce the emergence of personalities?”. As seen in the results above, we see that responsiveness can evolve in populations and in fact we found that it could even spread when the price for being responsive was a factor 50 higher than suggested by the paper of Wolf et al. In the first responsiveness model, we found that there is a clear difference in strategy of responsive and unresponsive individuals. When introducing the responsiveness as a tendency, the same equilibria were found. In short, both questions have a positive answer.

It seems that by introducing responsiveness to a population, a clear difference in strategy is sparked as two obvious personalities emerge. Responsive individuals tend to go for cooperation, while the unresponsive individuals end up defecting most of the time. This is probably due to a discrepancy in the pay-off matrix of the game dynamics of the snowdrift game. Between α12 (b – c) and α21 (b) for an unresponsive individual interacting with a responsive individual, α21 gives a higher fitness than α12, and therefore defecting is the strategy which will be more successful. As a result of this, unresponsive individuals in a highly responsive population tend to defect after reaching equilibrium (see figure 3, high initial responsiveness). Due to the emergence of responsiveness, the average cooperativeness of the population decreases and the number of unresponsive individuals becomes very low. Only after the unresponsive individuals change their strategy to defect more often, will they regain a substantial part of the population.

Wolf et al. suggested a maximum price for responsiveness to emerge in an unresponsive population. This is based on the variation of the population, but, as can be seen in figure 1, the standard deviation fluctuates a lot in the population. The maximum price that was calculated was based on the standard deviation being 0.02, but in the higher peaks the standard deviation could reach 0.1 and higher. Could this explain the responsiveness still emerging at a price of 0.5? If we took the standard deviation of 0.1, the max price would be 0.03, which is still a factor of a least 15 lower than what we found.

Interestingly, we see in figure 7 that the standard deviation reaches a high level in which the price is not too high to let responsiveness emerge. The standard deviation of the cooperativeness among unresponsive individuals stays very high and therefore a clear difference in personalities is very likely. When introducing the responsiveness as a continuous trait, the standard deviation did also reach a high level after which responsiveness emerged. Although, it did not stay high but went to a very low level. This suggests that no personalities emerged. Overall, some interesting findings have been observed, which definitely need more research to clarify the continuous responsiveness scenario. One suggestion would be to let the strategy chosen by the individuals evolve over time, so that responsive individuals do not immediately choose the opposite of the partner.

The emergence of personalities was observed in the first responsive model, but introducing this as continuous responsiveness showed little variation. Something to look into for the future would be adding a slight change in price for every individual, so that some individuals pay less fitness price for being responsive than others. In this way, it could be that personalities even with a continuous responsiveness could emerge from an unresponsive population.

Another suggestion for future research is the introduction of signalling. Individuals can show different behaviour than the behaviour they would exhibit in an interaction. This could influence the emergence of responsiveness in a population. Finally, studying meta-populations could perhaps be interesting. Due to smaller population sizes in these meta-populations, variation would be larger. Therefore responsiveness would be able to emerge more easily.