TDT4280 - Project

Alexandre Balon-Perin and Stian Kristoffersen

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1 Task 1

1.1 Observational Game

In an observational game (figure 1), the speaker informs the hearer of the topic. Afterwards, an utterance is produced by the speaker. Eventually, the hearer sends a performance report to inform the speaker if he understood the utterance.

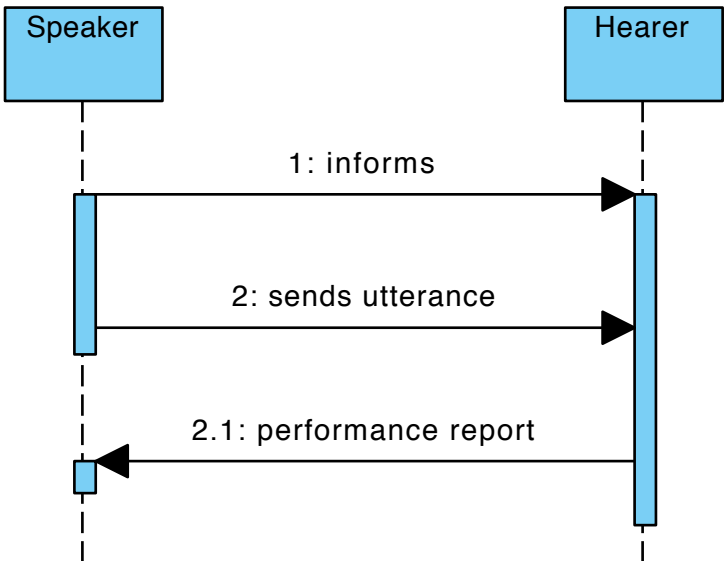

Figure 1: Observational Game

1.2 Guessing Game

In a guessing game (figure 2), the speaker first produces an utterance without informing the hearer of the topic. The hearer then guess what the topic is. Finally, the speaker reveals the topic.

1.3 Selfish Game

In a selfish game (figure 3), there is almost no interactions between the speaker and the hearer. The speaker only produces an utterance. The hearer guess the topic but does not ask for verification.

2 Task 2

The communication in itself is not autonomous because there is a predefined interaction protocol.

However, agents in THSim can be compared to hybrid agents where the agent reacts to object in the environment, try to match topics and meanings and depending on the agent type, they coordinate results and update their states.

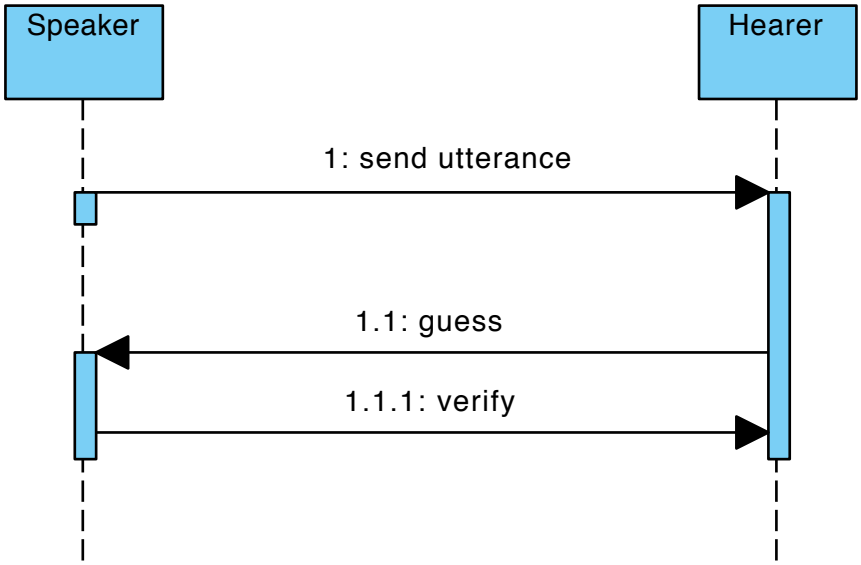

Figure 2: Guessing Game

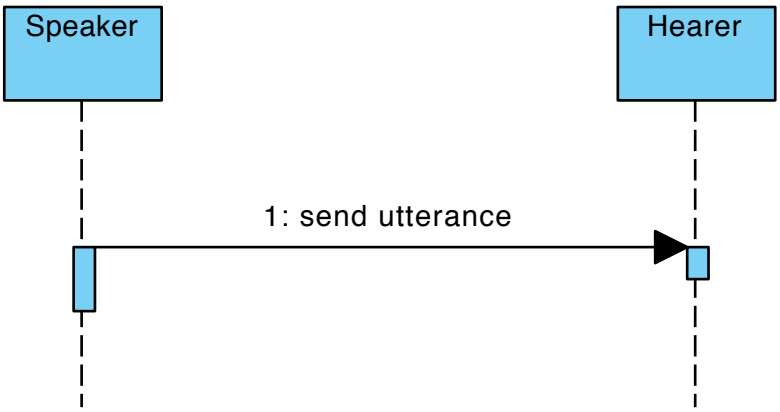

Figure 3: Selfish Game

The agents are cooperating to create and share a common language. The language is shared proactively by the speakers in a result sharing way. Even though two agents interact at a time, the learning rate is proportional to the number of agents which already share share a subset of the common language. In fact, this is a case of parallel problem solving.

3 Task 3

The goal of task 3 is to investigate the effect of learning from experienced agents compared to agents on the same level. Table 1 shows the features that were fixed during the different experiments.

Fixed Features	Value
agentType	Compositional
gameType	observational game
selected features	SXY
nGames	10000
nIter	5
popSize	10

Table 1: fixed features

Table 2 shows the values of the parameters that were modified between the experiments.

index	pAdultS	pAdultH
1	1	0
2	0	0
3	0	1
4	1	1
5	0.5	0.5
5b	0.7	0.3

Table 2: Experiments

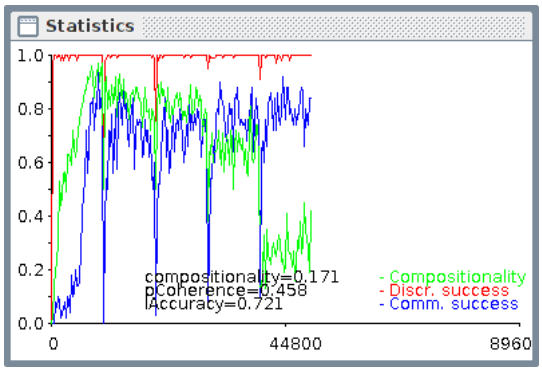

Figure 4: Experiment 1

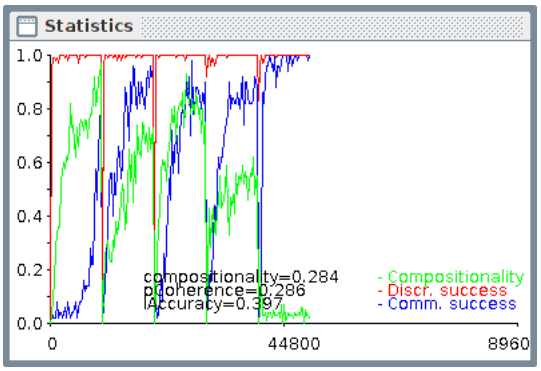

Figure 7: Experiment 2

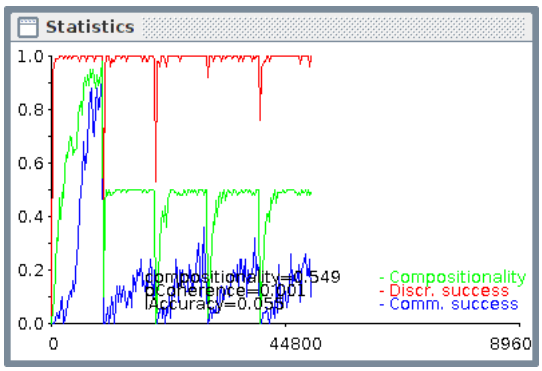

Figure 5: Experiment 3

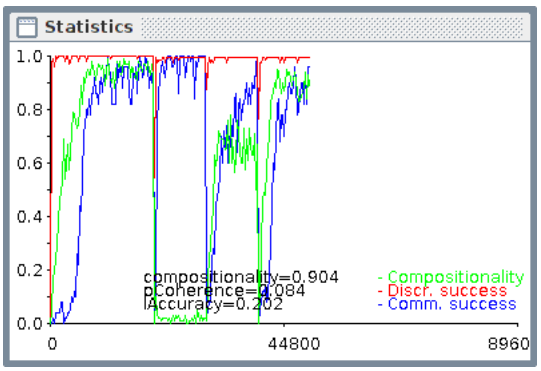

Figure 8: Experiment 4

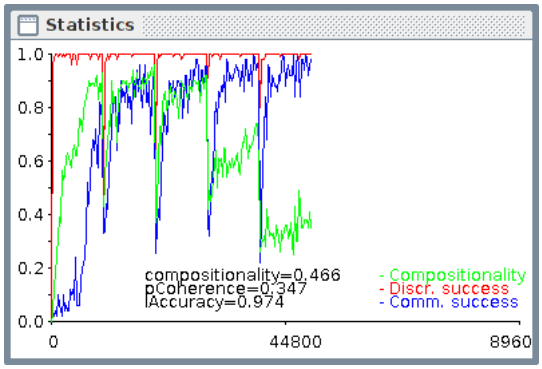

Figure 6: Experiment 5

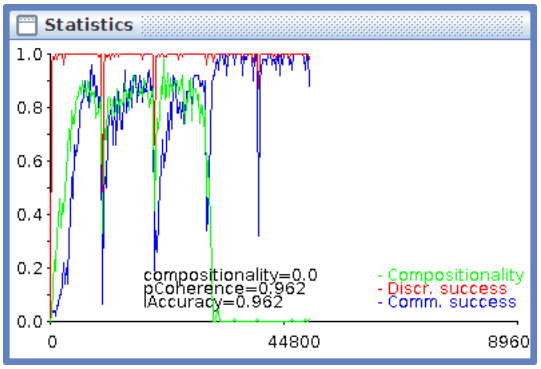

Figure 9: Experiment 5b

Figure 10: Task 3

Discussion

1 The first generation does not learn the language fully. Since they teach the next generation, the new generation cannot get better than the previous one.

2 Only the children speak to each other. After the first iteration, the number of children is half the population which results in a faster learning process to reach a common language. Therefore, only the first iteration can be compared to the previous experiment and the result obtained in this case is worse.

3 Children are make up new words and teaching them to the adults. This is the very opposite of passing on knowledge which is the reason why this produce the worst result.

4 After the first iteration, the whole population is educated. In the next iteration, the educated half of the population is talking to each other increasing their performance. However, in the third iteration, both educated adults and children with no knowledge are inherited from the last iteration which decreases the overall performance. It only gets worse with more iteration.

5-5b After any iteration, the common language of the adult population is suboptimal. By having adults hearers, they can continue to develop and by having children speakers, the common language avoids getting stuck. This behaviour is similar to the algorithm "Simulated Annealing" which avoids getting stuck in local minima by using variations.

The optimal approach turns out to have mostly adult speakers and children hearers. However, a small amount of children speakers and adults listeners improves the overall performance of the learning process.

4 Task 4

The goal of task 4 is to investigate the effect of varying game types. Table 3 shows the features that were fixed during the different experiments.

Fixed Features	Value
agentType	Holistic Flat
gameType	observational game
selected features	SXY
nGames	10000
nIter	5
popSize	10
varGames	true

Table 3: fixed features

Table 6 shows the values of the parameters that were modified between the experiments.

Experiment	pOG	pGG	pSG	pAdultS	pAdultH
6	1	0	0	1	0
7	0	1	0	1	0
8	0	0	1	1	0
9	0.33	0.33	0.33	1	0
10	1	0	0	0	1
11	0	1	0	0	1
12	0	0	1	0	1
13	0.33	0.33	0.33	0	1
14	1	0	0	0.5	0.5
15	0	1	0	0.5	0.5
16	0	0	1	0.5	0.5
17	0.33	0.33	0.33	0.5	0.5

Table 4: Experiments

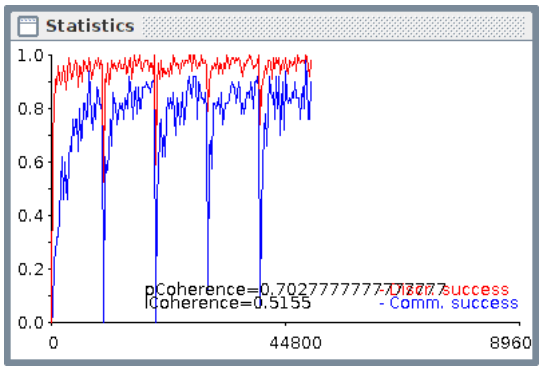

Figure 11: Experiment 6

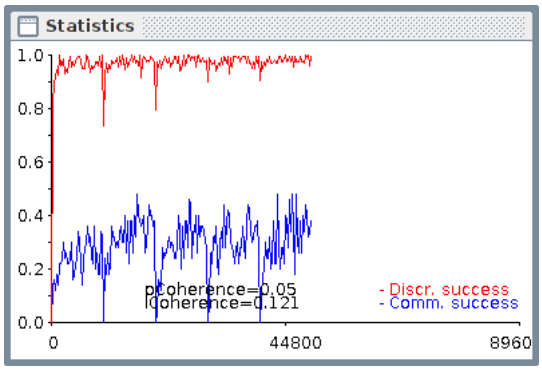

Figure 12: Experiment 8

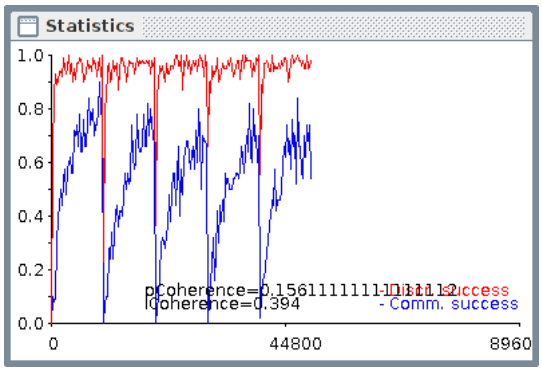

Figure 13: Experiment 10

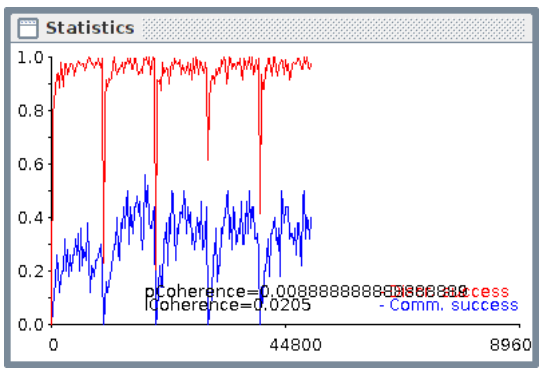

Figure 14: Experiment 12

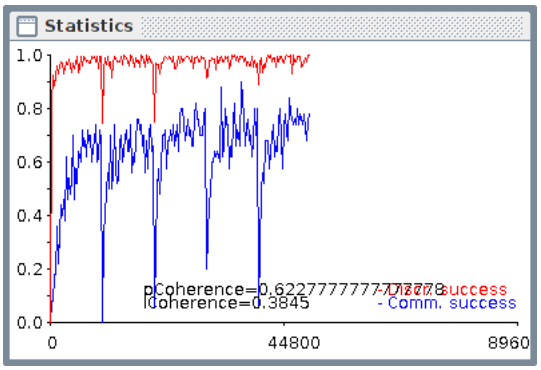

Figure 15: Experiment 7

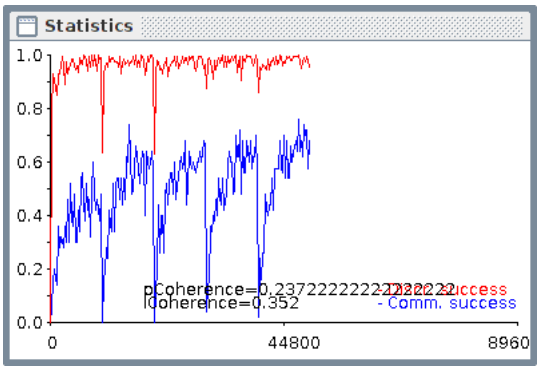

Figure 16: Experiment 9

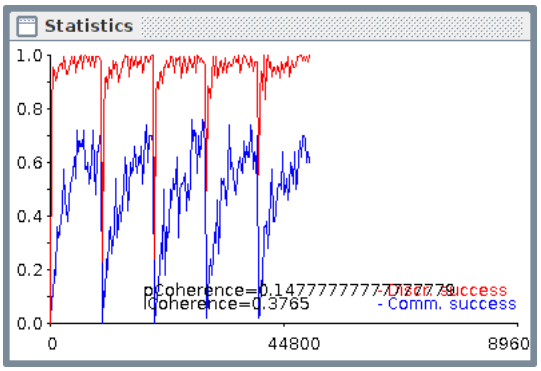

Figure 17: Experiment 11

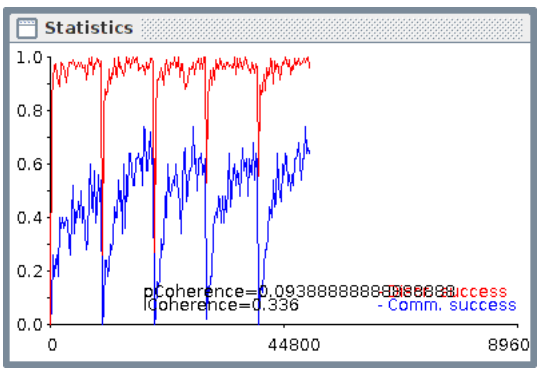

Figure 18: Experiment 13

Figure 19: Task 4: Experiment 6 through 13

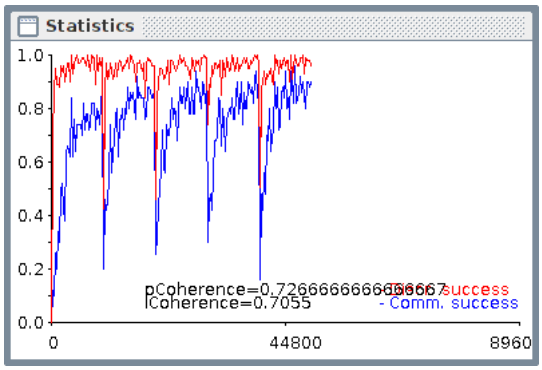

Figure 20: Experiment 14

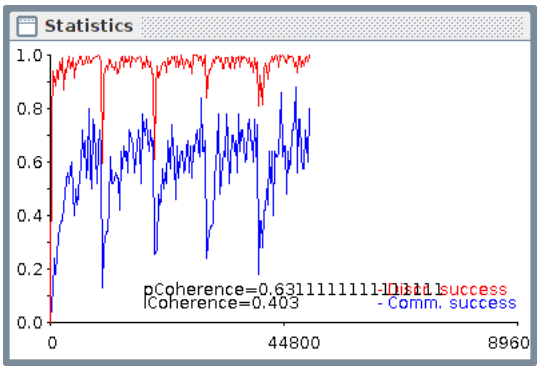

Figure 22: Experiment 15

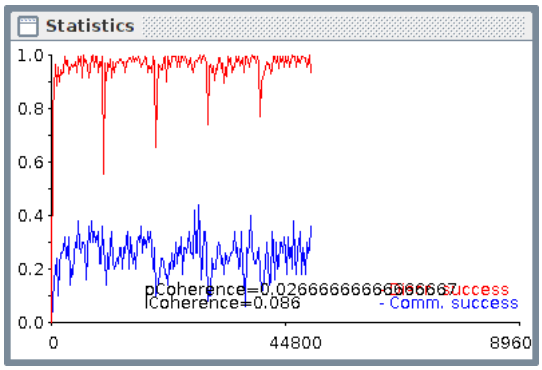

Figure 21: Experiment 16

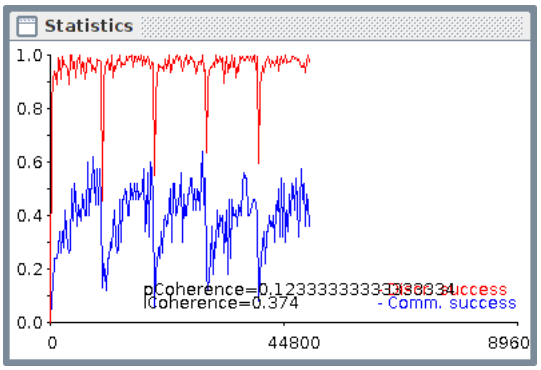

Figure 23: Experiment 17

Figure 24: Task 4: Experiment 14 through 17

Discussion

6-9 In this experiment, the adults are the speakers and the children are the hearers. From best to worst, the games are ranked as observational game, guessing game and selfish game. When doing a third of each, the result obtained is qualitatively close to the average of the three separate games. Therefore, it doesn't seem like any of the game influence the overall performance more than the others. Not surprisingly, the observational game beats the others because it is the approach which is the most direct and exchanges the most information. On the other end, the selfish game exchanges little information and poor performance.

10-13 In the experiments 10 to 13, only the children are speakers and the adults are hearers. The performance profile is similar. As previously seen in task 3, having only children as speakers gives overall worse performance but the ranking of the games stays unchanged.

14-17 This experiment looks at the best performance obtained in task 3. Half speakers are adults and half hearers are also adults. The performance profile is again the same. For the observational and guessing game, the results are similar to the case when only adults are speakers (experiments 6 to 9). The reason why the results are not better as in task 3 might be because the agent type has been changed. More interestingly, it is actually performing worse for the selfish game and for the experiment with one third of each game. For the selfish game, one could argue that it is better to listen to and try to understand an experienced speaker than a child when trying to learn a language. In other words, it is easier to make sense of structured information rather than immature speech. The performance of the last experiment with a third of each game is worse due to the part of selfish games played.

As expected, the games that exchange the most information outperform those that do not.

This makes the observational game the best suited to learn a language whereas the selfish game is not. According to the experiments, the choice of effective learning mechanism does not depend on who you learn from.

5 Task 5

The goal of task 5 is to investigate the effect of varying the population size (popSize) and the number of games per iteration (nGames) proportionally. This ensures that the average number of games per agent is the same. The value used for pAdultH (0.7) and pAdultS(0.3) are the ones giving the best results in task 5. Table 5 shows the features that were fixed during the different experiments.

Fixed Features	Value
agentType	Compositional
gameType	observational game
selected features	SXY
nIter	5
pAdultS	0.7
pAdultH	0.3

Table 5: fixed features

Experiment	popSize	nGames
18	5	5k
19	10	10k
20	15	15k
21	20	20k
22	25	25k
23	30	30k
24	35	35k
25	40	40k
26	45	45k
27	50	50k

Table 6: Experiments

Discussion

As expected, the learning process takes a longer time as the population increases. Even though each agent receives the same training, it takes longer to reach a common language. This is because the knowledge of the language has to spread throughout the population. Each experiment has only been done once, therefore fluctuations in the results should be expected. In fact, a fluctuation of one generation was observed to obtain 80% of communicative success with a population size of 60. To be conclusive, each setting should be run several times and the average of these runs should be computed. However, this process is very time consuming when the population size gets bigger than 30. Unfortunately, THSim was not build to automate repetitive runs.

In general, when looking at the rate of the growth of the language in the population, we see that it starts slowly and then increases rapidly and eventually slows down again. This is similar to the logistic function for a population growth which is the solution of (1).

$$\frac{\mathrm{d}P}{\mathrm{d}t} = rP(1 - \frac{P}{K}) \tag{1}$$

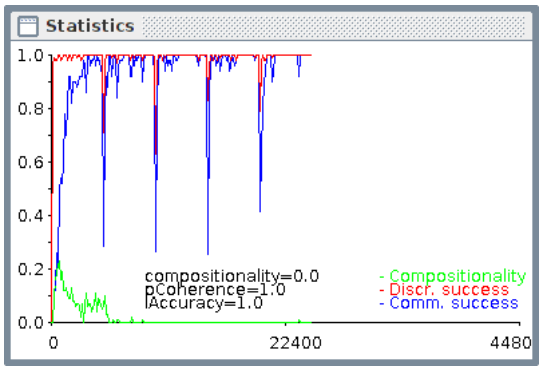

Figure 25: Experiment 18

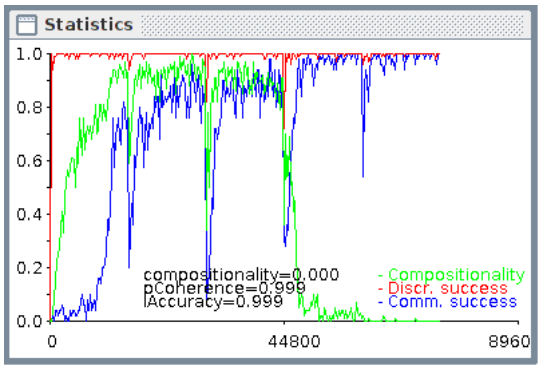

Figure 26: Experiment 20

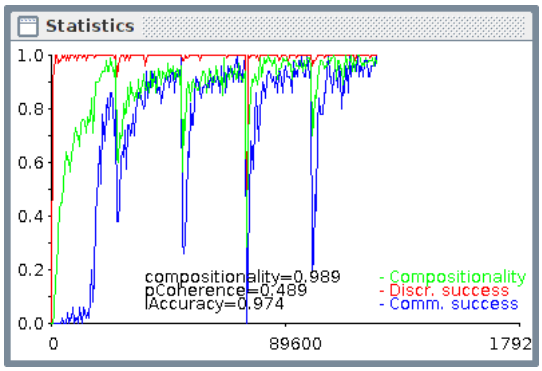

Figure 27: Experiment 22

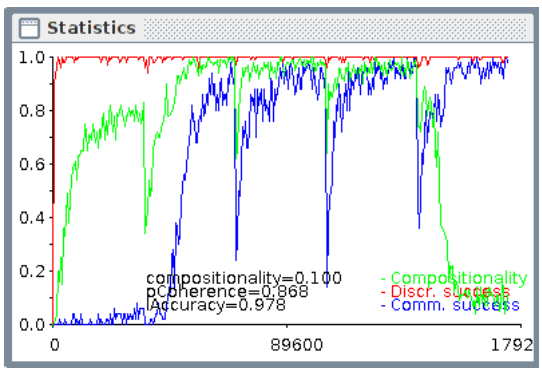

Figure 28: Experiment 24

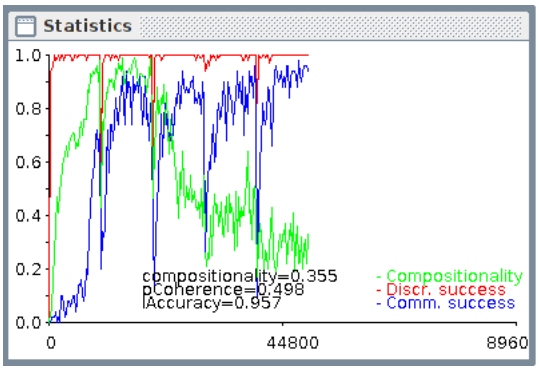

Figure 29: Experiment 19

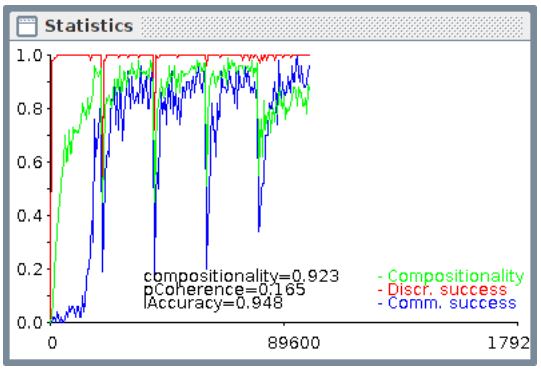

Figure 30: Experiment 21

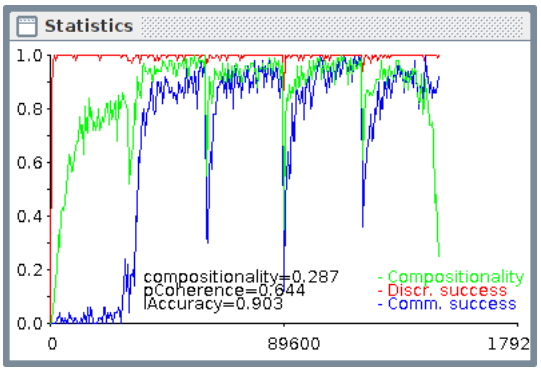

Figure 31: Experiment 23

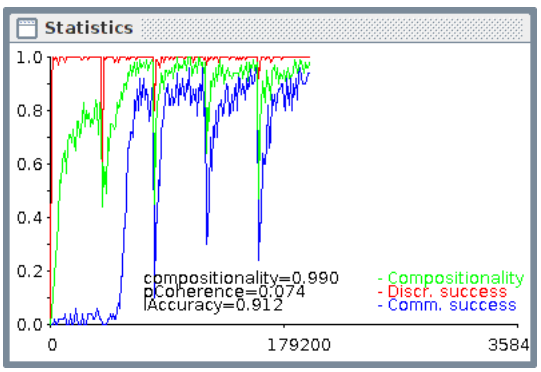

Figure 32: Experiment 25

Figure 33: Task 5:Experiments 18 through 25

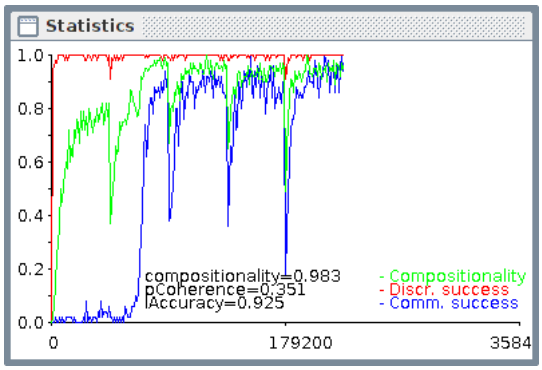

Figure 34: Experiment 26

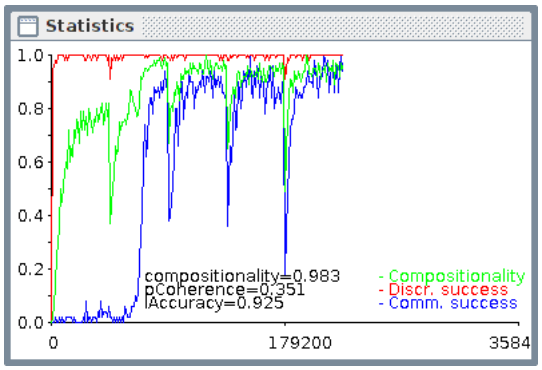

Figure 35: Experiment 27

Figure 36: Task 5:Experiments 26 through 27

P is usually the population size but here it represents the topics that the common language can describe. r is the growth rate. K is the available resources which is, in this case, the total number of topics. As the resource becomes scarce, the growth will go down.

This means that when there is only a few topics that are not part of the common language, the agents will spend most of their time using what they already know rather than developing the common language.

6 Conclusion

To conclude, the ideal way of developing a common language is to play observational games. This is very similar to real life where children learn a language by associating sounds and images. In the simulations, it was observed that it is useful for adults to keep on learning and also to learn from children. In real life, this could be other languages and dialects or people making up new words that become common in a language.