The Drunken Mice

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Abstract

In this project we investigate, how a theory about the impact of drugs (alcohol) on cognition could look like. We used simulated agents ("mice"), which live in groups, to understand the effects of alcohol. The agents are programmed according to the Psi - theory, which is a theory about the interaction of cognitive, emotional and motivational processes. We added to the normal (simulated) environment of the mice, which includes sources of food, water and "healing herbs", sources of "julihuana", which is a beer-like beverage. Although in the original formulation of the theory the consumption of drugs was not considered, the behaviour of the "mice", which have access to "julihuana" changed in a way, which exhibits strong parallels to human behaviour. The drunken and (after a time) often addicted mice lost their social contacts (less friends), their cognitive processes (perception, remembering, planning) became rough and shallow. The mice felt "strong" when drunken and very weak without julihuana. When drunken therefore they became very aggressive, but depressive when without julihuana.

Keywords: memory; plan; addiction; cognitive map, alcohol; action-regulation.

Cognition and Drugs

In nearly every human culture drugs play an important, often however detrimental role. Men (but animals, too) are inevitably attracted by drugs. The relationship of drugs to cognitive processes is close. Especially intellectuals, writers, painters, composers seem to exhibit a strong tendency to alcoholic beverages (see Lange-Eichbaum, 1986). Accordingly you will find Beethoven as a heavy drinker, Mozart, too. Goethe every day drank two bottles of wine, he was an alcoholic according to the standards of today, Schiller drank even more. A theory about human behaviour should be able to answer the question, why drugs are so attractive. In this paper we will try to answer this question – and some more about the impact of alcohol on cognitive, emotional and motivational processes.

The Mice

The mice are simulated agents, which live in an environment an example of which can be seen in figure 1. The environment forms an island with different regions. On region 1 food is growing, region 2 offers water, region 3 offers healing herbs, where the mice can cure their wounds. Wounds can be the result of aggressions of other mice (the mice can even kill each other!) or the results of falling stones in certain dangerous regions in the "world" of the mice. Region 4 is such a dangerous region. (The "world" of figure 1 is only an example. The mice' worlds normally are much larger!)

In "alcoholic" environments some of the waterholes are exchanged by regions which offer julihuana instead of water. Julihuana is an alcoholic beverage, a kind of palm-beer. It was invented by Julia Hagg and therefore is called julihuana.

The mice do not know their environment completely, but have to explore it to learn where fresh water, food or healing herbs (or julihuana, region 5) could be found or which regions are dangerous. The mouse' memory contains cognitive maps in the form of landmark paths to goals in the environment. A projection of such a path on the "world" of the mice can be seen in figure 1.

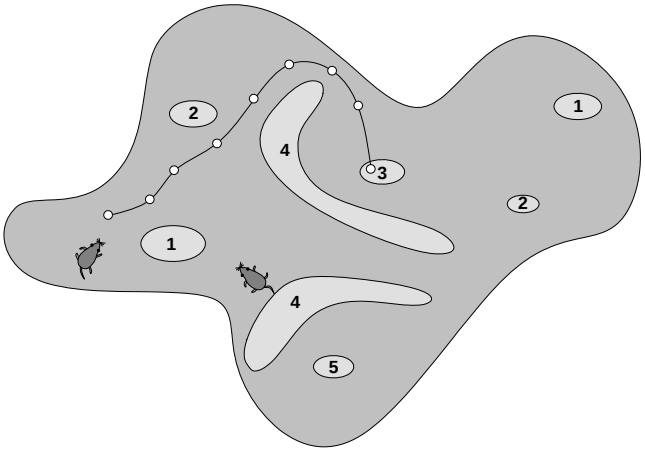

Figure 1: The environment of the mice.

Additionally the mice have a social memory about their friends and enemies. The mice have a desire for social contacts and those mice with whom they have such contacts become "friends". Friends help each other with food or water or when a mouse is attacked by another one. (Such an aggression naturally is the basis for enmity!) Help in a dangerous situation strengthens friendship. If it is not strengthened the memory of friends and enemies decays by time. The same is true for the cognitive maps of the environment.

The mice can get offspring. For this purpose they have sexual desires, too. The mothers educate their children, i.e. they "tell" them, where food or water can be found and

which places are dangerous and who is a friend or an enemy.

The Psychic Organization of the Mice

Figure 2 exhibits a rough sketch of the mice' psychic organization. There is a motivational system, which controls the direction of behaviour. Additionally there is a unit 'Perceive and Act' which transforms the general directives of the motivational system into real actions. It adapts general plans or directives to the conditions of the current situation. The third unit, Thinking, is used if no appropriate plan for the actual goal (the actual motive) is available in memory. In this case the unit Thinking tries to construct a new plan by planning activities.

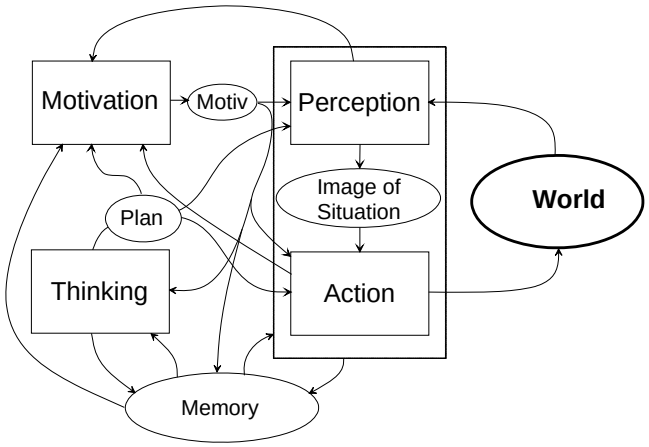

Figure 2: The Aristotelian soul of the mice.

This organization is nothing else but the basic organization of the "soul" which Aristotle postulated (Aristoteles, Buch II). It includes the three basic Aristotelian "capabilities", Motivation, Perception (and Action) and Thinking, which together produce the capability of "striving". This Aristotelian Architecture is rough, but it is sound and a good starting point to debate the overall structure of the "soul". (The Aristotelian concept of "soul" is quite simple and straightforward and astonishing close to information theory: "Soul" is nothing else but the controlling and monitoring device of the body and the soul itself is a physical function.)

The mice are programmed according to the Psi-theory, a theory about the interaction of cognitive, motivational and emotional processes (Bach; 2009; Dörner, 1999; Dörner et al. 2002). The mice are cognitively reduced (to fit in rather big numbers into a normal PC), but emotionally elaborated. Therefore these beings are called "mice", as mice are nice, but small. Now we are going to explain some basics of the Psi-theory.

Motivation The unit Motivation is the core of the whole system. Its organization is shown in figure 3. There are a number of "tanks" (mathematically: accumulative stores), which represent the need-system. The "Hunger-tank" for instance is filled up by the intake of food and emptied by the consumption of energy by the activities of the body. Attached to the tank is a system, which indicates the setpoint deviation of the actual level in the tank. All the other tanks are organized in the same way.

We assume that five needs or need groups are sufficient to generate all kinds of human motives, namely existential needs (hunger, thirst, pain, …), sexuality, affiliation (need for binding to a group), certainty (need for predictability of the events in the environment or for the explanation of such events) and competence (need for mastery, need for the ability to solve problems). These needs can amalgamate to form "macro-needs" or need-amalgames.

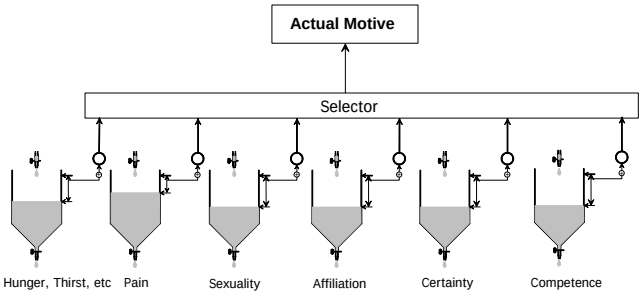

Figure 3: The motivational system.

The Selector-system is very important for action regulation. It makes a choice between the different active needs (setpoint-deviation >0) and selects the need with the highest motive-strength. Motive-strength is calculated according to the expectancy (of success) × value (of the need) - principle. The higher the setpoint deviation the higher is the value (of the satisfaction) of the need. The expectancy of success is calculated either on the basis of the knowledge about goal-paths in memory, i.e. knowledge about paths which lead for instance to a water hole. Additionally the "general competence" is taken into account, which is the basis of the calculation of success-expectancy, when knowledge about goal-leading paths doesn't exist. In this case the "General Competence" is heuristic competence, the confidence in finding a method to reach the goal. "General competence" is nothing else, but the level of the competence tank. Roughly the system Selector works according to the expectancy–value - principle: it selects a goal according to the setpoint deviations of a tank, the goals which are known to result in an increase of the level of the "tank" and the success probability. This is calculated on the basis of the success-probability of a known operator (for instance a landmark – path as representing a sequence of motions towards a goal) and the level of the competence tank, representing "general competence".

The tanks for affiliation, certainty and competence are "information-tanks". This means that no material or energy fills or empties these tanks, but signals, information. In the case of the affiliation tank the inputs are signals of legitimacy (L-Signals; Boulding, 1974). These are signals of "okness", a clap on the shoulder or a smile. For the certainty tank the input are signals of certainty, for instance a progno-

sis which comes true. The tank is emptied by signals of uncertainty, a prognosis which comes false or a situation which is inscrutable. Input signals for the competence tank are signals of efficiency, the solution of a problem for instance is a signal of efficiency. But each satisfaction of a need is a competence signal, too. The competence-tank is emptied by failures.

Additionally to the emptying signals for the affiliation and the competence tank a "leak" exists. These tanks therefore empty by time, without any signals. This is very important, as this means, that automatically a desire to reestablish social relations and to reaffirm competence will arise after some time.

Cognition Cognitive processes are processes of perceiving, memory search and planning, i.e. construction of a plan as a sequence of steps towards a goal. The system Selector of the motivational system activates memory search to look for goal leading paths. If it does not find such a path it activates a planning process to construct a sequence of steps towards a goal. This process in the mice is realized as the GPS – process of Newell & Simon, 1972, the General Problem Solver. – It is very important to understand that cognitive processes are emotionally modified. This means, that their form alters as a consequence of emotional changes.

Emotion We believe that it is sound to consider emotions not as processes of their own, but as forms of the organization of motivational and cognitive processes dependent on the level of the uncertainty and – most important – the competence tank. So for instance anxiety means a low level in the certainty and the competence – tank. These low levels produce a high level of arousal, a low resolution level, i.e. rough cognitive processes, flight tendencies, but aggressive tendencies, too. Additionally in anxiety "weak" processes of exploration may be started to diminish uncertainty. Anxious persons however will mostly try to defend their model of the world against falsification, for their image of the world is the last hold to protect them from despair. Therefore anxious persons will easily believe, what is in correspondence with their image of the world, but will never accept news disconfirming their view of the world. This combination of credulousness and distrust is a modulation of perceptive processes and impedes effective exploration.

In a similar way other emotional states and processes can be characterized as systems of cognitive and motivational processes triggered by the level of the certainty and the competence tank. Emotions are adaptations of cognitive and motivational processes to competence and certainty as measured by the level in the respective tanks. An empty competence tank "says": "You should be extremely cautious when acting, as you are helpless! Whatever you will do could be a mistake or failure with a high probability!" (Naturally the competence tank does not "say" anything. But it generates the respective behavioural tendencies.)

An empty certainty tank "says": "You are not able to foresee, what will happen. Therefore your vigilance should be as high as possible. Not one moment you should stop to monitor your environment!" Under such conditions of high vigilance elaborated planning processes are nearly impossible; therefore vigilance impairs planning processes and hence the quality of action.

The most basic emotions are pleasure and unpleasure. How do they fit into this model of emotions? In the simplest way! Pleasure is a filling of the competence tank. This implies to feel strong, to relax (because there does not exist any danger which cannot be overcome), to foresee nothing but successes in the future.

And unpleasure? It means emptying the competence tank. This however means to feel weak, depressive. Normally it means stress, high arousal, low resolution level of cognitive processes. The current problems seem to be insolvable. Future looks dark.

The General Organization Figure 4 shows a rough sketch of the interplay of processes and data according to the Psi-theory. The System "Selector" generates an actual goal and looks for an appropriate action. For this purpose it looks for a transition from the momentary given situation to the goal. If it finds such an operator, the operator is executed. If not, planning is activated. If this is successful the plan is run. This could be successful or not. If not, explorative activities are activated to gain a better understanding of the structures and possibilities of the environment and hence to be able to construct another plan. If this is successful, the new plan will be run, otherwise the system shifts to a behaviour of the trial-and-error type.

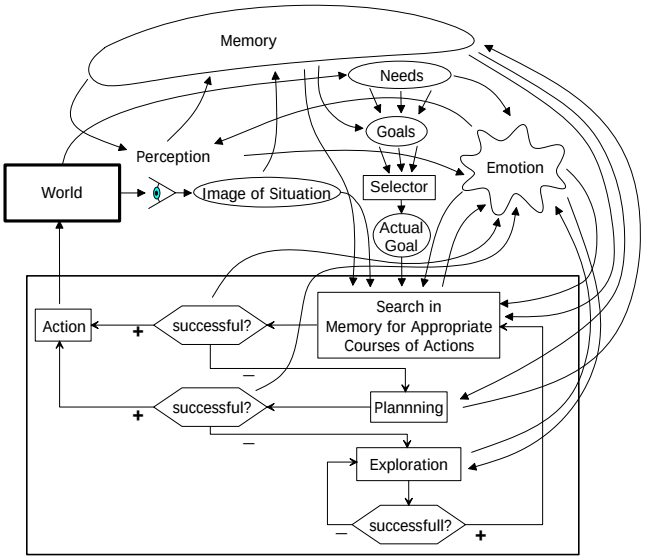

Figure 4 The general organization of the behaviour of the mice. See text.

Very important are "interrupts". As the level of the tanks changes nearly from moment to moment, the conditions for the selection of an actual goal change , too, as the basis of the selection of the actual goal is the expectancy-value – principle. If because of failures the level of the competence tank becomes low, the behaviour of the mice looses sustain-

ability. The goals will change rather frequently as with each failure the competence of the actual intention decreases and other intentions may take over.

The Effects of Alcohol

What are the impacts of alcohol on human behaviour? The direct effect is to feel good, to feel "strong". Everything becomes manageable; there are no problems. On the other hand the ability to follow one line of thought is impaired. Sustainability diminishes. Thinking becomes rough and shallow, but to a certain degree is less supervised and therefore could be "creative" (see Feuerlein, 1998; Lindenmeyer, 2005).

Abuse of alcohol for a longer time results in a loss of social contacts and an inability to sustain intentions for a longer period. Short time and working-memory seem to be impaired. Self-control suffers and people often lose their job because of inefficiency. Alcholics often become depressive (when not drunk) see Schuckit, 1994.

To investigate the impact of alcohol to the mice' behaviour we used environments which were different only in that respect, that in the alcohol-version some of the waterholes were replaced by sources of julihuana. When a mouse drinks julihuana, the first time simply because she is thirsty, there will be an input to the competence tank. This means that the mouse will feel good, much better than if she had drunk water. The input to the competence tank however is different to a normal efficiency signal as it is not accompanied by learning a new method to overcome difficulties or by the affirmation, that, what has been done, has been an appropriate method to achieve goals. Alcohol produces an efficiency signal without any effort. What is the effect of julihuana to the behaviour of the mice?

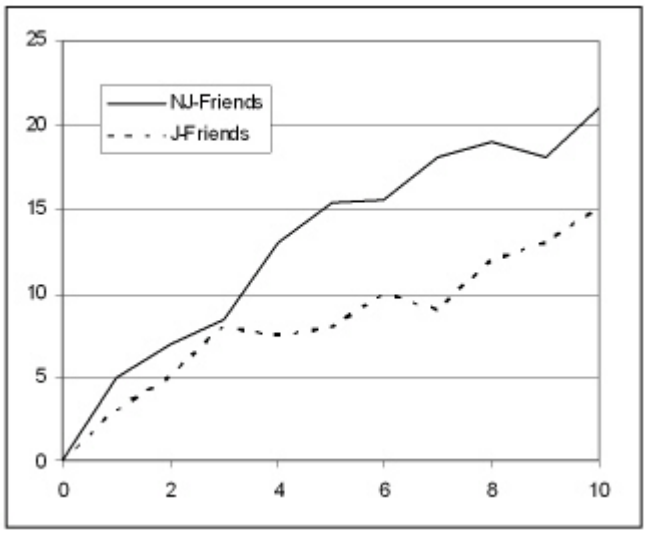

Figure 5: The average number of friends (per mice) of the J- and the Non-J- mice over a period of 100000 (=10) cycles. (One cycle corresponds to 30 Mice-minutes. 100000 cycles mean 50000 hours or 5.7077 years or 5 years and 258 days.)

Motivational Effects

The most significant motivational effect is that the julihuana-mice (J-mice) have a much lower affiliative motivation than the "normal" mice (Non-J-Mice), which have no access to Julihuana. Normally for the mice social contacts are the main source of competence, of "feeling good". To a high degree affiliation is replaced by alcohol with the J-mice! Figure 5 shows that the (average) number of friends diminished considerably with the J-mice. The same applies to the enemies (not indicated on Figure 5.) - The difference is significant on the 0.001 – level. (The same applies for all the other differences between the J- and the Non-J-mice in this article.)

The shrinking of the social contacts of the mice is in good accordance about what a lot of authors report about alcoholics. It is typical for alcoholics, that their social environment shrinks, see Feuerlein, 1998). This again had a severe impact on the population development of the mice. Figure 6 shows, that the growth of the population is much slower with the J-mice than with the Non-J-mice.

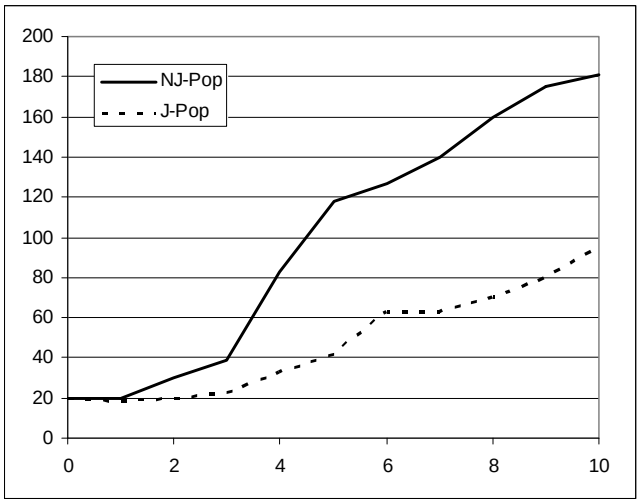

Figure 6: The growth of the population.

This is mainly due to the fact that the J-mice had less sexual contacts. For the mice, as for men, too, mostly sexual contacts have the condition that the partners like each other, are "friends", so to speak. As the number of friends is less for the J-mice than for the others, the number of sexual contacts diminishes, too, with the consequences visible on figure 6.

Additonally to the impact which julihuana has on the competence tank, we increased in another experiment the impact to the certainty tank. This means, that julihuana diminishes uncertainty (lack of predictability and "explainability" of the "world"). This additional impact of julihuana to the need-system of the mice increased the attractiveness of the drug considerably as visible in figure 7. This effect is due to the lower resolution level of the cognitive processes. Perception and remembering on a low resolution level be-

come rough and "overinclusive". Objects, which are only similar are treated as if they were identical. An apple is a pear!

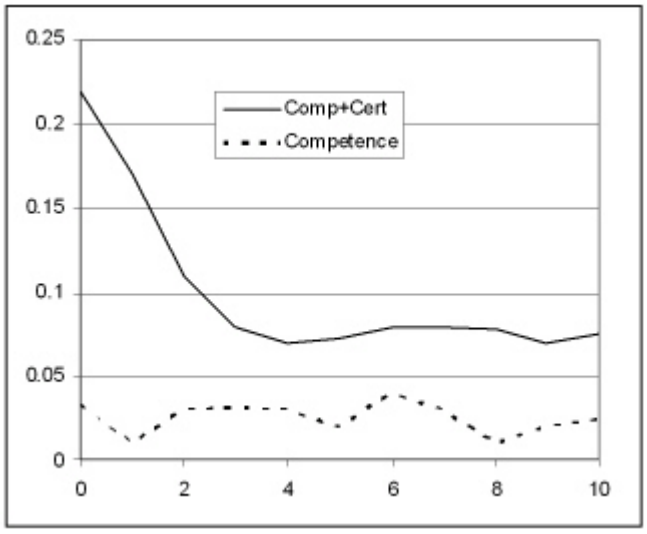

Figure 7: Attractiveness (measured as relative frequency per cycle when alcohol is actual goal) of julihuana when it only has an effect on competence and when it has an effect on uncertainty, too.

May it be, that this is the main reason for the attractiveness of drugs for writers and composers? One of the reasons to create something is to bring order to a world which is perceived as chaotic. The lowered resolution level under the influence of a drug decreases the chaotic character of the world and therefore satisfies the need for certainty. And therefore a drug relieves the "suffering about the world", which is characteristic for many intellectuals.

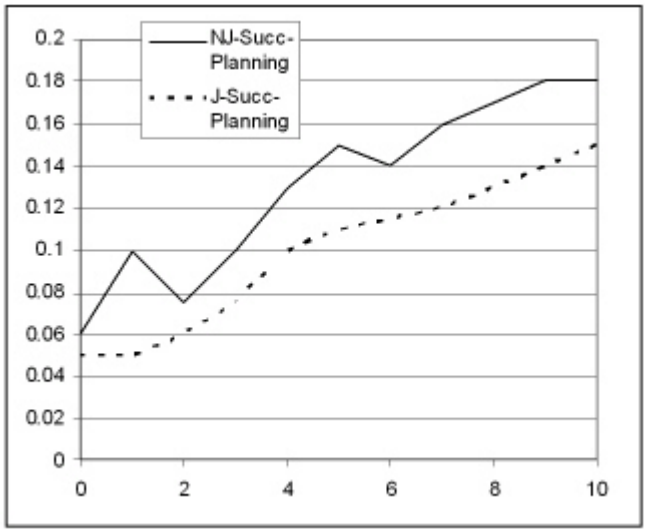

Figure 8: Successful planning activities (relative frequency per cycle) of the J-mice and the Non-J-mice.

Cognitive Effects

To take alcohol has an impact on the cognitive abilities of the mice. Cognition becomes rough, perceiving and planning on a low resolution level become deficient. Figure 8 shows the number of successful planning activities with the J-mice and the Non-J-mice. The relative number of successful plans diminishes significantly with the use of alcohol.

This is due to two factors. One is, as above mentioned, the low resolution level of cognitive processes, which produces bad plans, which will not work. The other one is the lower sustainability of the planning activities with the J-mice. They loose the hope for success earlier than the Non-J-mice, because the level of the competence tank is generally lower for the J-mice (see figure 10).

Planning normally means to construct a branching "tree" of operations or locomotions to fill the gap between the starting point and the respective goal. A branch in this tree is abandoned if there seems not to be any hope that it can be extended further in the direction of the goal. In the mice such a decision is based on the competence level. As the level of the competence tank is lower with the J-mice than with the Non-J-mice, the J-mice have the overall tendency to give up planning too early.

Emotional Effects

Rough and undifferentiated perception is one of the reasons for the J-mice to be more aggressive than the Non-J-mice. On figure 9 this is visible. This difference is due to the fact that the Julihuana-mice simply fail to perceive the strength of their respective opponent because of the low resolution level and therefore become more often entangled in a fight.

Additionally when drunken the J-mice simply felt stronger than their respective opponents and therefore were more daring and incautious.

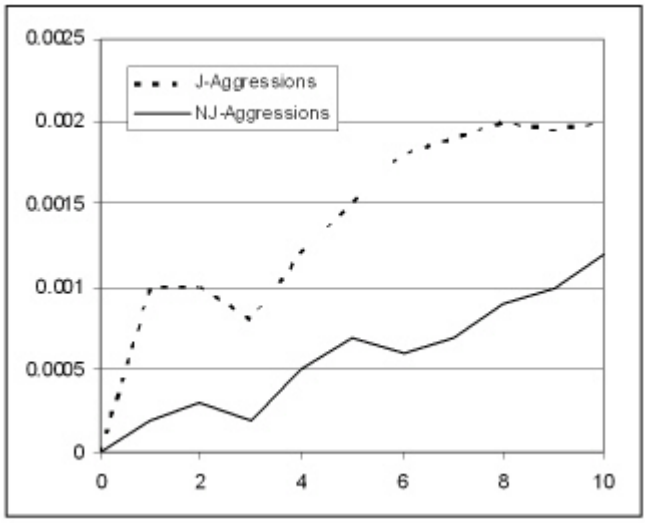

Figure 9: Aggressions in the population of the J- and the Non-J- population (relative frequency per cycle).

But when they were not drunken, and this was the case even for the J-mice most of the time, the J-mice felt less strong, as in this state they noticed their decreased abilities. Figure 10 shows the averaged desire for competence (inverse to the competence feeling) for the J-mice as compared to the Non-J-mice. The J-mice felt generally weaker (higher need for competence) than the mice without access to julihuana.

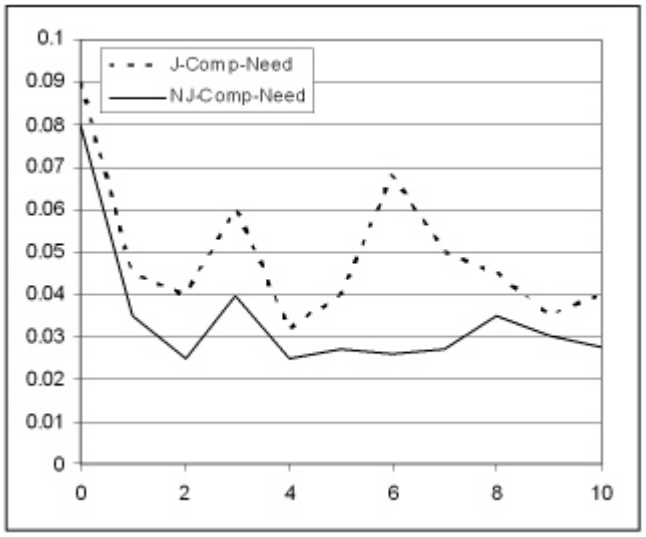

Figure 10: Desire for competence in the J- and Non-J-population.

Summary of the Results

"What I cannot create, I do not understand!" said Richard B. Feynman. We tried to simulate the effects of the consumption of alcohol on psychic processes simply by introducing a beverage for simulated agents, which effects the level on the "competence tank". This produced a number of results which are in good accordance with what is known about the effects of the use of alcohol with humans. The social contacts of the mice diminish and their ability to organize extended actions, too. Additionally the mice became both: more daring when drunken and more cautious and anxious when not drunk.

As we originally not constructed the Psi-theory to cover the phenomena of the consumption of alcohol we consider the success in reproducing these effects as a validation of the theory.

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