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Experimental context and scientific truth – some basic constructivist reflections

Asked about the context of their research, most scientists from Western industrial nations will probably claim freedom of research and teaching to be the most important fundamentals of their work. This corresponds with the scientific-theoretical ideal of the autonomous researcher, who trusts only his own studies and experiments and draws responsible and independent conclusions which, in turn, can be examined or disputed by a free community of researchers. Truths need to be substantiated within such contexts and will be held good only as long as there is a viable majority-consensus within the scientific community.¹ John Dewey, in particular, has intensively worked on the relationship of truth and context. According to Dewey, truths are brought about by examinations which always necessitate inquiry tools (hence, a certain instrumentalism) and procedures (experimental methods in all variations). This is regarded as the essential context in which science is enabled to successfully find adequate truths. Though, as also pointed out by Dewey in one of his later works, in “Context and Thought” (LW 6, 3-21), the imputed position of freedom is, on its part, again subject to prerequisites. Being members of a specific culture, researchers are placed within the contexts of their time, their societies, and their individual relationships. Could it be that this cultural context spoils the scientific-theoretical ideal of independence? Dewey argues that there is no contradiction, as only the contexts of research are concerned, but not its ideals contested. He said: “I do not mean, that a philosopher can take account of this context in the sense of making it a complete object of reflection. But he might realize the existence of such a context, and in doing so he would learn humility and would be debarred from a too unlimited and dogmatic universalization of his conclusions.” (LW 6, 13)

I would like to take this as a starting point and ask from a constructivist perspective whether we should not generally have a closer look at the prerequisites of our scientific constructions. This is also suggested by Dewey, when he states with reference to the linguistic prerequisites of every scientific work:

„Habits of speech, including syntax and vocabulary, and modes of interpretation have been formed in the face of inclusive and defining situations of context. The latter are accordingly implicit in most of what is said and heard. We are not explicitly aware of the role of context just because our every utterance is so saturated with it that it forms the significance of what we say and hear.” (LW 6, 4)

Dewey has an extraordinary sense for the relevance of the context when he argues that it is never only the close and direct research field which is concerned in scientific examinations, but also the context it is placed in. According to him, this is already determined by the background of the experimenter.

„This includes the antecedent state of theory which has given rise to his problem. It takes in his purpose in arranging the apparatus, including the technical knowledge which makes a controlled experiment possible. On the other side, there are the habits and present disposition of the subject, his capacity to give attention and to make verbal responses, etc., etc. Without the phase of the context found on the side of the experimenter, there would be no scientific result at all, but an accident without theoretical import. The phase of context supplied from the side of the subject furnishes the causal factor determining the appearance of the quality discriminated.” (LW 6, 7-8)

¹ According to the constructivist perspective, holding a truth claim on the grounds of a majority decision is not sufficient in the long-term, but also needs to be viable concerning the collected data or practices.

This is exactly where Dewey also deplores the sciences' "unlimited extension or universalization" (LW 6, 8) of research results, irrespective of their context. The key-phrase, as determined by Dewey, reads:

„When context is taken into account, it is seen that every generalization occurs under limiting conditions set by the contextual situation.“ (LW 6, 8)

I would like to follow this fundamental insight and apply it to the experimental methods of science. I believe that this procedure is thoroughly along the lines of Dewey, although I will come to novel results as I am considering two completely different contexts of scientific and, at this, experimental methods of work. In order to avoid delivering a rather abstract presentation, I will apply metaphors, a procedure which is regularly made use of in philosophy. Although with metaphors one always runs the risk of coarse simplification, they also offer the attraction of discovering essential contexts by precisely this way of simplification. This shall be the basic intention of the following reflections.

1. Rational-empirical science as reflected in the prisoners' dilemma²

a) Description of the prisoners' dilemma

Science always deals with incidents. Every incident is regarded as singular for the present, but science also strives for generalization. In the following given case, a singular incident evokes a truth problem and induces us to reflect on potential generalizations:

The warden of a prison summons three prisoners and tells them: "For grounds that I will not explain to you, I will grant one of you the chance to gain freedom today, which actually all of you deserve. You need to consent to an experiment in which you will have to solve a riddle. The first one to solve the riddle – by reflection or chance – will be set free immediately."

The prisoners consent without further consideration, as freedom is their utmost desire. Hence, the warden determines the following:

The prisoners are tied to a chair each, lined up in a row in such way that the last one looks at the backs of the two men in front, the one in the middle looks at the back of the man directly in front of him, and the first one looks at the wall. The warden approaches and instructs them (cf. *Fig. 1*):

"There are five discs, three black and two white ones. Each of you has one of them attached to his back and the first one to tell me the color of the disc on his back will be released. By admitting that you don't know the answer, your detention will continue as determined. Yet, by giving the wrong answer, your detention will be doubled."

The prisoner at the rear end sees a black disc attached to each of the men's backs in front of him. Consequently, he concludes that there are one black and two white discs left over. The warden asks him: "What is the disc's color on your back?"

The man considers. He would need to take a guess, as the disc could be either black or white. Deciding that the risk of having his detention doubled is too high, he answers: "I don't know the color."

He thinks by himself: "If only he had two white discs attached to their back, it would have been an easy task." This is what the two other prisoners think as well.

Now the warden approaches the prisoner in the middle and asks again: "What is the disc's color on your back?"

² For a more detailed interpretation of the prisoners' dilemma, cf. Reich (1998 b, Ch. 3).

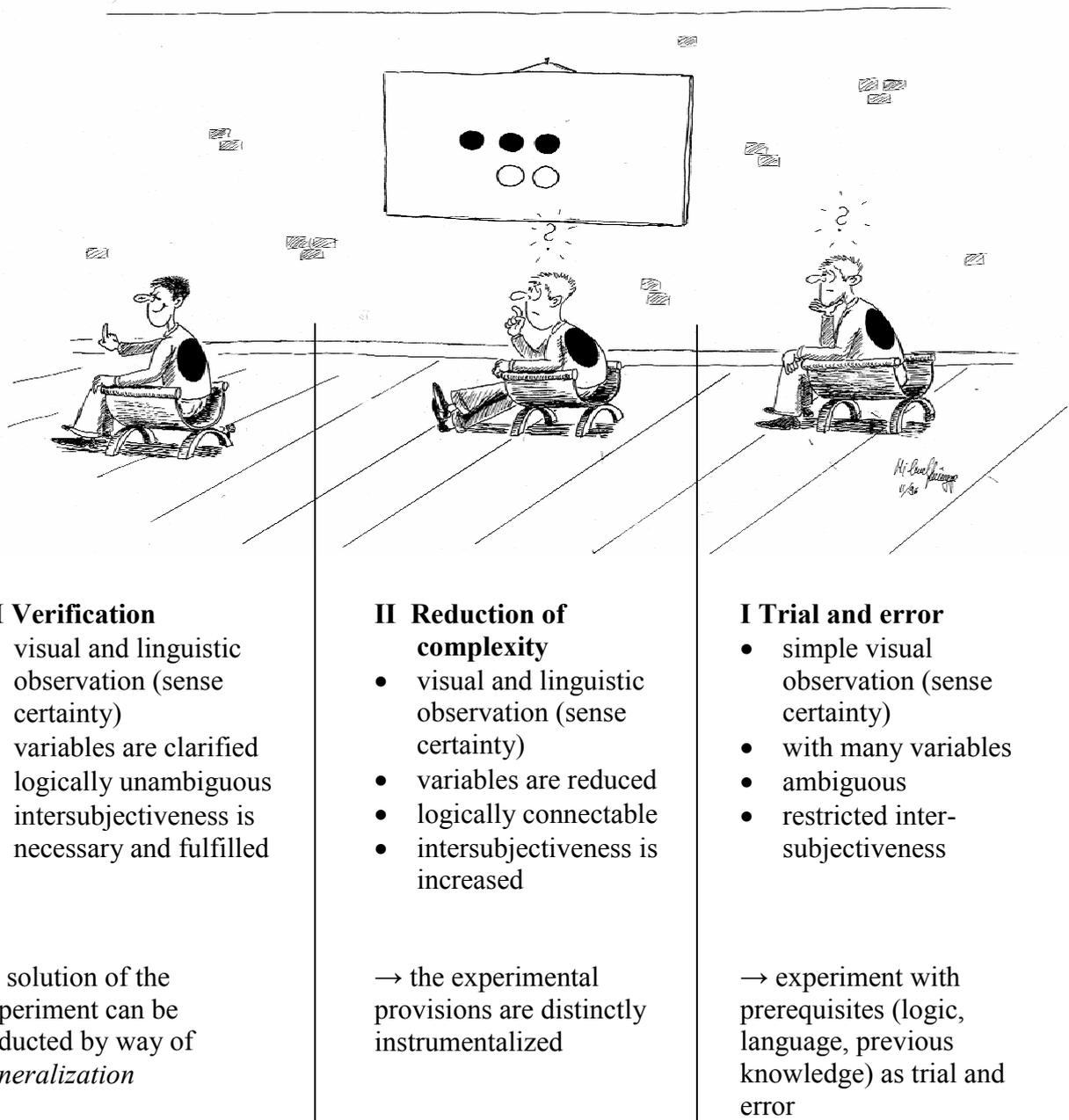


Fig. 1: Prisoners' dilemma with tied prisoners

The man reflects: If the disc on his back and that of the man in front of him were white, the man behind him would have known his own disc's color. But because the first man's disc is black, the man in the rear is unable to tell his own disc's color, both, if he – the man in the middle – has either a black or a white disc attached to his back. He stops thinking at this stage because it seems to risky to guess the color. So he says: "I don't know the color." And he thinks by himself: "If only the man in front of me had a white disc attached to his back, I would have known for sure that my disc is not white. Had it been white, the man in the rear would have known the answer. Given the fact that the disc of the man in the front disc is black, mine could be either."

Now the warden approaches the prisoner in the front, amicably puts his hand on his shoulder and asks for a last time: "What is the disc's color on your back?"

He immediately receives the correct answer: "Black!"

b) Solution of the prisoners' dilemma

The prisoners' dilemma can be easily solved by means of logical conclusion, given that the prisoners follow basic logical rules. Because the prisoners are tied to their chairs, we, as distant and external observers, as well as the prisoners themselves, are given the opportunity to increasingly narrow down the provisions and the development of the problem solution. If the prisoner in the rear had known his color, this would have been only possible if the warden had provided him with the advantage of placing two white discs in front of him. As this was not the case, the second prisoner was able to conclude that the disc attached to his back had to be either black or white. Seeing the black disc on the man's back in front of him, one possible solution is that two black discs are left over. As the disc is not white – had it been white and had his disc been white as well, the man in the rear would have known his own color – he is left with two logical possibilities: black or white. By admitting not to know his color, he makes way for the third prisoner's conclusion.

Why the warden showed so much favor to the third prisoner, we are unable to tell. Also, we can only speculate why the two other prisoners did not risk to guess.

c) Conclusions from the three observation steps (cf. Fig. 1)

Proceeding from the above example, I am going to draw some conclusions. I choose a construction that will, at the same time, tell us something about methodological possibilities of experimental research. From the perspective of each prisoner, how do they perceive their more or less intuitive application of the logical rules?

Trial and error: The first prisoner represents a form of knowledge determined by trial and error. This approach must not be despised. Dewey, for instance, regarded it as a fundamental form of conducting studies. Especially if we are unable to describe an incident thoroughly or if we are lacking the knowledge of all variables which needed to describe the situation and the incident, we are faced with an experiment with an open ending. The prisoner is in the same situation: Although he notices and perceives the situation in a multi-digit logic, he is unable to reduce the number of variables. The essence of each experiment is to restrict the conditions in such way that it results in only one unambiguous answer which may be observed by everyone in the same way and therefore be regarded as intersubjective true. If everyone follows the rules, the result can be repeated using identical conditions. Here, science speaks about content which has been empirically proven by facts (criterion of empirical content). It is the nature of most experiments to aim at creating causal, unambiguously observable conditions. The first prisoner in the above example has no chance to come to an unambiguous solution of the problem. If he chooses to guess, he risks to double the length of his detention.

Nevertheless, the first prisoner is in a situation which can be regarded as quite typical for scientific thinking and research, as it is equally influenced by prerequisites, i.e. linguistic and logical abilities, previous knowledge of the problem, or the ability to abstract with regard to the task. These prerequisites form the context as mentioned in the beginning, when I cited Dewey. Although the situation itself is tied to a simple visual observation, the observer still needs to detect the number of variables and thereupon abstract the ambiguity of his solutions. Furthermore, as an observer he experiences only restricted intersubjectiveness with the other prisoners, i.e. he is heard by the others, while at the same time he is unable to directly communicate with them.³

Transferring the above observer's behavior to actual research, one can state that our solitary observer would need to experimentally extend his research context in order to obtain an unambiguous result. He would need to 'make the positions talk' by changing the concept of the experiment to obtain a solution of his own. In order to do so, he would need to occupy

³ There are a number of other prerequisites regarding the prisoner's linguistic and other abilities which will, though, find no consideration here.

another position, but his position as a prisoner is too confined to allow him to put the variables into place and reduce them by himself. The said position is solely reserved to the warden.

Reduction of complexity: The second prisoner can already take his predecessors' verbalization into account and is not merely committed to his own visual observations and logical speculations about rationally undecidable solutions. Although the context is now more evident, the observer still lacks the crucial restricting criteria. Ultimately, he, like the first prisoner, would need to take a lucky guess to come to the right decision. By trusting his own exact observations only, the second prisoner actually shows a model scientific behavior.

We have now reached a decisive stage within our metaphor: If the second prisoner did trust his own observations only, he would immediately fall back to the position of the prisoner in the rear and therefore exercise trial and error. Now, he could also conclude that the prisoner in the rear has already logically concluded and is just not daring to take a guess. If this had been the case, he would have taken the risk to guess. As this has not happened, we can rely on logic. To be precise: We must be able to rely on it when leaving the stage of trial and error behind in order to perform a reduction of complexity. Such reduction is the core of all scientific procedures if we want to reduce variables and gain solutions in a rational way. Although visual and sensual observations play a certain role, language and the definition of possible and excludable variables come to the fore more distinctly. The reduction of variables presupposes a connectivity to something that previously has been recorded as a prerequisite and been defined as a restriction. This is, after all, what is suggested by defining theory as a fundamental context for the experimenter. The prisoner of our example knows that the prisoner behind him does not know. This knowledge is very foreseeable in our example: As the problem is only based on three black and two white options, a considerable logical gain of complexity reduction is feasible. This is based on the intersubjective presumption that the prisoner behind him is telling the truth. The experiment would be terminated anyway, if he was not telling the truth, but taking a guess instead. In science, this probably occurs more often than we would wish for, in particular, if several different researchers are unable to experimentally verify, in an intersubjective way, what individual statements relate to in a chain of ascending knowledge. But for the time being, we are not met by such complications in our experiment.

It is interesting to see how the gain of complexity reduction, and therefore the possibility of an unambiguous solution, was achieved. We can observe the intervention of an instrumentalization which is already laid out in the experimental procedure. Again, this correlation has been particularly emphasized by Dewey. Experimental research always relates to an instrumental approach.⁴ The second prisoner instrumentalizes his observations in relation to the logical presumptions concluded by the man behind him, as well as in relation to the unambiguous establishment of the remaining variables which are determinable from the man in front of him. Here, the instrument of the experiment lies in the transfer of the externally observed multi-variable logic to one's own logic and its reduction in an exclusion procedure. This is typical for all experiments and reductions of complexity that occur therein.

Verification: Only the stage of verification will successfully terminate a research process; this is, if successfully terminating is understood as finding an unambiguous solution for a problem. Such verification is never free from prerequisites and context, as is displayed in the above constructed experiment. Verification in science always means more than mere sense certainty followed by spontaneous conclusions. Within his constructed logic, the third prisoner depends on his predecessors' statements. Had they not followed the rules of

⁴ Concerning this aspect, cf. e.g. Dewey's "Logic" or "Experience and Nature".

observation, he would draw wrong conclusions. He cannot just rely on his sense certainty⁵ in order to come to a direct or an immediate truth which is only controlled by himself. Yet, by perceiving and summing up the observations of the other observers, he is able to draw an unambiguous conclusion which finally means his liberation. Therefore, it is essential for him that his predecessors stick to the rules of observation and logic. He will rely on this in his decision-making process, and only failure will be able to set him right. In his position, he will therefore probably be one of the most zealous defenders of scientific standardization and validity of experiment, and, indeed, everything is designed to make him safely succeed.

From the position of verification, we understand why the experimental method with its instrumental character has experienced a triumphant advance in all applied sciences. Ultimately, it is only from a finally verifying position that the success, respectively the solution of a problem, becomes evident. If we apply Dewey's five step model of constructive learning to the third prisoners behavior, we could say that after the emotional reaction to a problematic situation, after the construction of hypotheses, and after the trials and errors and the gradual encircling of possible solutions he comes to a solution of the problem which can be applied to similar problems and their solutions in the future.⁶ As for Dewey, these are stages of action within the process of problem solving, as well as learning stages which we necessarily need to pass through if we want to solve a problem. This doubling of acting and learning shows that experimental intelligence is not only reserved to science, but is also an essential prerequisite for the acquisition of knowledge in general. This method of experimental thought can be regarded as the entry into scientific work if learning is refined by instrumental and experimental scientific methods. It can therefore be regarded as a procedure which secures the entry into scientific work only by such methods of learning.

The third observer is also subject to visual observations. Yet, these are not sufficient at all to draw a verifiable solution in his liking. He needs to logically clarify the variables and therefore needs to exclude the ones that cannot be verified in order to find the correct solution. Intersubjectivity turns out to be an essential prerequisite, even if the observer does not directly face his intersubjective partners, but is only able to hear and communicate indirectly with them. It can be regarded as prototypical for science that one needs to rely on the dependability of what one has heard.

A generalization of the detected solution is only feasible from the third position, although, according to Dewey, we need to pay attention to the question, which context we may apply this to. Finding a high logical level enables an easy derivation of the prerequisites and variables which lead to the solution of this or similar case(s).

It could be argued that my metaphors may only be applied to cases in which people have to experimentally master certain riddles or logical brainteasers, yet, that they are not suitable with regard to the scientific or technological determination of empirical facts. Let us take a look at a simple example which has served for the specification of arguments in another context of discussions between pragmatism and constructivism:⁷ The statement that a pure sample of tin melts at 232 degrees Celsius at one standard atmosphere can unambiguously be confirmed in an experiment in every place in the world, therefore it is verifiable. How can this example be transferred to the chosen metaphor?

This example reveals the way in which science deals with successful and correct results. They are regarded as warranted knowledge only after their verification. Regarding them as verified

⁵ Sense certainty is a term used by Hegel (*sinnliche Gewissheit*). It is in the sense of Dewey a kind of primary experience, a subjective immediate experience "being there".

⁶ Concerning this aspect, cf. e.g. Dewey's "Reflex Arc Concept in Psychology" and the transfer of this theory into his learning concepts. Cf. e.g. John Dewey "How We Think". In German we give an introduction to this aspect in Hickman/Neubert/Reich (2004).

⁷ The example originates from Dewey and was used by Larry Hickman as an objection against an allegedly relativistic way of thinking in constructivism. Cf. Hickman's essay in Hickman/Neubert/Reich (2004).

in one of the pre-stages would be nonsense, as knowledge is not certified in these stages. I would like to examine possible pre-stages in the above displayed example.

This question is not insignificant. It has, due to its line of reasoning, initiated a long-lasting debate within the disciplines of methodical constructivism or “Kulturalismus” (*culturalism*)⁸ in Germany: Whenever models or versions of reality, which can be regarded as verified, have been constructed in science, they have been based on pre-stages which have already been integrated into the result as prerequisites. Here, we are faced with an explicit search for contexts. According to this theory school, more complex verifications, which are comprised to explanatory models or scientific theories, are based on certain proto-theories. They are, so to speak, archetypes of defined previous processes which are reconstructed in order to comprehend the current stage of research.⁹ I am going to illustrate this with a very simple example: An exact description of the mechanism of cogwheels in empirical correlations can only be given if the mechanism of wheels is presupposed as prototypical.¹⁰ Altogether, the methodical constructivism aims to conclude from practices, as applied in technological or scientific procedures, to the conditions that have to be regarded as actual or potential prerequisites for such procedures.

With reference to our example with the melting point of tin, we need to presuppose as a pre-stage, for instance, vessels in which substances can be melted at a high melting point without destroying the vessels themselves. Further, the controlled application of fire can be regarded as another pre-stage etc. An exact methodical reconstruction can only be conducted if we manage to establish a preferably complete list of all prerequisites for the melting of tin. But the discussions in Germany on methodical constructivism and *culturalism* show that the natural and technological sciences have nearly no interest in a preferably complete list of prerequisites in their respective last practical application, although the reconstructions in detail may be very interesting from a science-historic point of view. A quest for such prerequisites has to be regarded as a rather theoretical or philosophical question which rationally tries to decode the preceding, without ever being able to fully accomplish this with more complex models. Yet, practical science seeks for actual verification and finds it by reduction of complexity. A preferably complete list asks too much from the single research project and is not regarded as sufficiently productive, inasmuch as the relevant potential of the new research is not deducible from it. Therefore, nearly no technologist or scientist, engaged in the current procedures of melting tin in (already existing) industrial environments, will be interested in the history of melting pots or, more general, in the history of fire during the history of man. From a pragmatic point of view, tin is being melted in the respective technology available at the time being. The constant care about general questions on such existence and its legitimation is of a philosophical rather than scientific nature.

d) Context and truth in the first prisoners' dilemma

How can we sum up the observations we have made so far? The following aspects seem to be essential with regard to instrumental and experimental action, learning, thinking and research:

- All experiments are always based on pre-constructions, i.e. on a connectivity which is dependent on the technical, practical, and cultural stage of development. These are relevant contexts. Yet, with regard to individual application, it is hardly customary to reflect on all these pre-constructions, because, due to the complexity of scientific

⁸ Concerning this, cf. in particular e.g. Kamlah/Lorenzen (1967), Lorenzen (1974), Lorenzen/ Schwemmer (1975), Gethmann (1979), Mittelstraß (1974). The approach is continued in particular by Peter Janich (1996) and Hartmann/Janich (1996, 1998).

⁹ Thus, e.g. the *Protophysik* (proto physics) by Janich (1997).

¹⁰ Concerning this example, cf. in particular Janich (2001).

research, adequate rules that present such research as reasonable can only be found in a restricted amount of cases.

- The solution of a problem in experimental procedures is achieved less by a complete reconstruction of all prerequisites, than rather by an instrumentally led limitation of the problem as well as of existing variables by a reduction of complexity. In many cases, this research logic tends to assume a linear, causal approach in order to enforce a clearness of statements and results. Here, applied methodical standards are of particular importance. Although research logic can be historically reconstructed according to its practices, there is usually no time for this during the research process.
- However, the context remains a burden within the research process, because, as argued by Dewey, only the reflection of the context helps to avoid exaggerated generalizations and universalizations.
- At the same time, it has to be mentioned that the method of complexity reduction is, again, never unproblematic with regard to further contexts. The complexity reduction may, for example, bring about the risk that the effects (e.g. with respect to environment or health etc.) of constructions (of inventions, technological options etc.) are not sufficiently taken into account. The application of nuclear energy or gene technology is readily named as an example, because the critics of these technologies contest that the risks in these research fields have been or are being studied to a sufficient extent.
- The given highest position – the stage of verification – secures a scientific result. It is regarded as a point of departure for new solutions and, therefore, for an extended comprehension which other studies will be able to follow in the future. Here, science is being standardized because the generated knowledge will be acquired by future researchers by way of learning in order to avoid to fail to meet the prerequisites of research. This offers a chance for connectivity, but can also prove to be the curse of being at a deadlock in traditional results which prevent researchers from achieving ground-breaking new results.

e) Selective interest

All the above listed knowledge confirms once more Dewey's approach in "Context and Thought". Context is regarded as the respective background which co-determines research. Such background, again, is already manifested in research itself. Additionally, a selective interest, as Dewey calls it, has to be taken into account (LW 6, 14). In the chosen experiment, the selective interest is particularly represented by the warden.

The warden in our example represents a governing, selecting form of knowledge. He is the actual experimenter, his power equals a god's eye view, and prisoners are put to his constructions' mercy. Furthermore, he has designed the experiment based on a hypothesis about the possible result: The experiment follows a logic which determines in advance that the prisoner in the front will succeed. Of course, the prisoners could have deviated from this logic by refusing to take part in the experiment, but the warden placed his confidence (in the pattern of the prison or the disciplinary action) in the human competing conflict, proceeding from the assumption of different interests in life.

And also a further aspect deserves to be noted: In an experiment that strives for unambiguous causality in order to deduct logical rules and true knowledge, the observation positions need to be distinctly separated. If a prisoner is part of the experiment, he must only perceive whatever the restricted logic and construction of the experiment allows him to perceive. Hence, the prisoner experiment would be futile if outsiders hinted something by shouting. Such interfering conditions would cause all prospects of control to fall apart. Also, the experimenter needs to assure himself of his own observations, if necessary by technical devices or further insider observers, in order to record the expected observations and to draw controllable conclusions. Yet, should the prisoners not trust in logic, but make their choice by

spontaneous contingency, our experimenter will fail in his conclusions. That is, he only observes what he expects to observe somewhere and somehow. Should other statements appear, he will perceive them as disturbing and will try to exclude them.

By shifting the perspective to the warden, we have performed a crucial change. While until now we assumed that the third prisoner controlled the experiment because he gained the correct solution, we now discern that the solution has actually been organized from a higher authority. Truth is not verified by the participants in the experiment, by its individual elements, but by the organizing experimenter who has designed and constructed the experiment as a whole. Whenever other people are involved in experiments, they are only jigsaw pieces or elements within a study and have to integrate themselves into the given contexts. Cultural context, as elaborated on hitherto, denotes the special context in which the experiment as such is included. Yet, context is also created wherever the experiment as such is regarded as a context by its elements or participants.

Who is this warden? He signifies a metaphor in my account. He stands as a metaphor for the power of an institutional or scientifically rationalized figure which is always set as a context for experiments of various forms. At the same time, this metaphor is not accidental. It follows the analyses of Michel Foucault, who has elaborated in a complex way, to what extent even scientific experiments, as well as all scientific discourses in general, are stamped by power.¹¹ If we consider the way Foucault investigates, for instance, the origin of mental homes, hospitals or prisons and thereby raises the question of the importance of discipline and disciplinary action¹², if we consider the way he recognizes that these are always institutions of power¹³, then we quickly perceive the warden's position in a different light. When working as scientists or experimenters, we also 'imprison' objects or persons in order to achieve unambiguous results. We will probably not like this description and will maybe refuse it because we claim to assume a neutral position when conducting experiments. Yet, there will be queries about the special interests and omissions that guided us to lead our research to an unambiguous result. This is not only valid for experiments with human beings, but also with objects. When melting tin, for instance, this is not just done like that, but always within the task's context.

In a world where labor is divided, we expect unambiguous statements from all those who try to obtain data on actuality. Wherever we deal with objects, the expectation is that such reification of our selective perceptions often will lead to a technical progress. Yet, we need to be skeptical towards reifications especially within the field of behavioral sciences: Here, we might to easily confuse people with objects, which will lead to inhumane imprisonment. Insofar, the above example of an imprisonment has not been chosen arbitrarily.¹⁴ The discourse of knowledge always tempts us to construct people to be test objects.¹⁵ From this perspective, the warden of our example represents a disciplinary science which is institutionally tied to social expectations and structures. As revealed by Foucault's analyses, this never happens in no field without the employment of power. It creates imprisonments.

¹¹ For an introduction, cf. e.g. Foucault (1976, 1978).

¹² Cf. Foucault (1973, 1991, 1992 a).

¹³ Such institutions of power are always connected with discourses which I will not elaborate on at this point. Fundamental are in this respect e.g. Foucault (1974); further Foucault (1993 a, b) and his works on sexuality and truth (1989 a, b, 1992 b).

¹⁴ This problem has been described in detail by George Devereux. He pointed out that not only the observed object's behavior is of relevance, but also all interference on behalf of the observer as well as his behavior. This has to be taken into account for a thoroughly substantiated statement on the behavior of the observers and the observed. Cf. Devereux (1967).

¹⁵ Well-known experiments in this regard are the Milgram-Experiment, the Stanford-Prisoner-Experiment, and the Wave.

Nevertheless, the warden is not absolute free in his decisions. He is appointed and state-controlled. Now, these are the signs of modernity: being scientists, we are part of such controlled order which we decline to see as a prison, but which, nevertheless, *imprisons* us in a more or less pleasant way.

It seems to be necessary to conduct a further change of perspective. I have been using the first person plural form during this text so far. Yet, who are *we*? Obviously, *we* are an observing instance next to the warden. Contrary to him, we draw conclusions from our perceptions in the process of our interpretation. As a matter of fact, I need to distinguish between my own observations and the ones of those hearing or reading this example. We could also take all those observation positions, which, again, observe us in our observing situation, into account. It cannot be avoided altogether to take an observing position, although the degree of activity of such positions may vary very much. Yet, science constantly tempts us to assume the warden's position as quick as possible, because this position enables us to control the rules of the scientific process in the best possible way. This appears to be rational, and we often confine the potential allegation of subjective arbitrariness by referring to the possibility of all admitted observers. This appears to be democratic. A reasonable acting between all observers within such democracy can only be reached if they are able to subjectively coincide and to agree upon the correctness of certain observations. From an observer's position, we then perceive such correspondence as an apparently common procedure of logic. We see through the prisoners' intentions and identify the warden as the ruling character. Although we may generally criticize the intentions of prisons and such tasks, and also doubt their necessity, we, nevertheless, do not doubt its inherent compulsory logic. While observing, we also have to admit that we would not have drawn other logical conclusions from any of the other positions. This is where we are touched by the power of science: These are inescapably logical constructions which obviously leave no room for exceptions in the process of concluding, not even from any of the various other observing positions. Nevertheless, we may have the uneasy feeling whether every experiment should be admitted in order to force such logic further on.

By forming an analogy to actual empirical research, one recognizes that twentieth century behavioral science – often conducted as animal research – followed similar constructions: An experimenter makes prisoners perform certain operations in order to deduct behavioral rules. Thus, the famous behavioral scientist Skinner managed to teach rats a specific behavior by consequently rewarding them. From this, he drew general conclusions on the learning aptitude and transferred them to human behavior by way of analogy. He demonstrated, for instance, that learning will be more successful when positively intensified, e.g. by feeding the rats, than when correlated with punishment, e.g. maltreatment. Such conclusions repeated the practical knowledge already accumulated by pedagogues during centuries of pedagogic practice. They had noted that approval stimulated the process of learning more successfully than corporal punishment, in particular, if the children's education took place in a dilemma of imprisonment, i.e. in places artificially isolated from their natural way of life, as, for instance, in schools.¹⁶ There were always observers and observed, always those taking the position of prisoners and those taking the position of controlling such imprisonment.

But while this way of causal thinking on a small basis has proven successful in technology – although even here we need to remain skeptical with regard to certain ensuing effects which have not been figured or are not calculable –, it has failed to do so in behavioral science. If such logic was to work in human behavior, a millennium lasting mutual observation of educational and behavioral processes would, by now, have needed to bring forth a logic of human behavior tending towards solutions that are increasingly complete and correct. For

¹⁶ This is valid since the 17th century, in particular on account of the agency of Comenius' works. Comenius emphasizes in his "Great Didactics", as well as in other studies, the necessity of the conducive use of motivation and competition amongst children with respect to learning.

instance, today we would actually need to know more precisely than hundred years before, how to successfully induce a person to what it is supposed to be. If we wanted to do this, the individual could no longer be regarded as an individual case. We thereupon should be able to precisely define how all people are supposed to develop. Irrespective of the preceding question whether such model of progress would be meaningful at all, the question remains whether it will succeed? It is obvious that we neither dispose of such logic, nor know how we are actually supposed to be in the future. At least, the claims towards such progress are manifold and have become more controversial in recent times. In *critical* reflection I suggest we should come to the conclusion that sects and groups who construct such rigid logic to feel secure in their lives are too narrow in thinking and living. More precisely, these are people that know very well who they are, what they want, and who despise others for not following their beliefs. It is here in particular where we perceive their members' bonds and imprisonment as a constraint that is too narrow to enable autonomous scientific research. They also are in need of a leader, like the warden of the above example, who arbitrarily determines their lives.

Therefore, particularly pragmatists and constructivists – to which I feel attracted – follow a different, more suitable approach. Such narrow and strictly causal experiments, which only lead into a thinking within categories of black and white, may be feasible and thinkable in artificial and isolated laboratories. Yet, human beings should actually be excepted from such experiments, at least from those regarding such existential aspects as in our example. In our observing position, we want to be questioned as subjects from an autonomous position. At least, we want to take up roles in our life which inform us whether a questioning position is allowed. We also expect science to render an account of this. This is due to the fact that in behavioral sciences we need completely different metaphors than the prisoners' dilemma we have constructed so far, at least, if we intend to conduct experiments which aim at the increasing understanding of contextuality. And also the question remains, whether the natural and technological sciences can be appropriately described by means of a strongly reductive model. Don't we run the risk to suppress complex contexts too easily? Although this will not meet the consent of all university researchers, large parts of them will have a similar approach to this problem. This is valid, in particular, for those working in the fields of behavioral and educational science, psychology, sociology and philosophy, as well as increasingly for natural scientists who aim to consider the context of their research as far as possible. Somehow we require the logic we have, just now, reconstructed as an action, but, at the same time, it somehow needs to be different from the one described above. In order to illustrate this, I would like to modify the conditions of the experiment and display a second example.

2. Science as a logic of relationships: the prisoners' dilemma of free walking prisoners

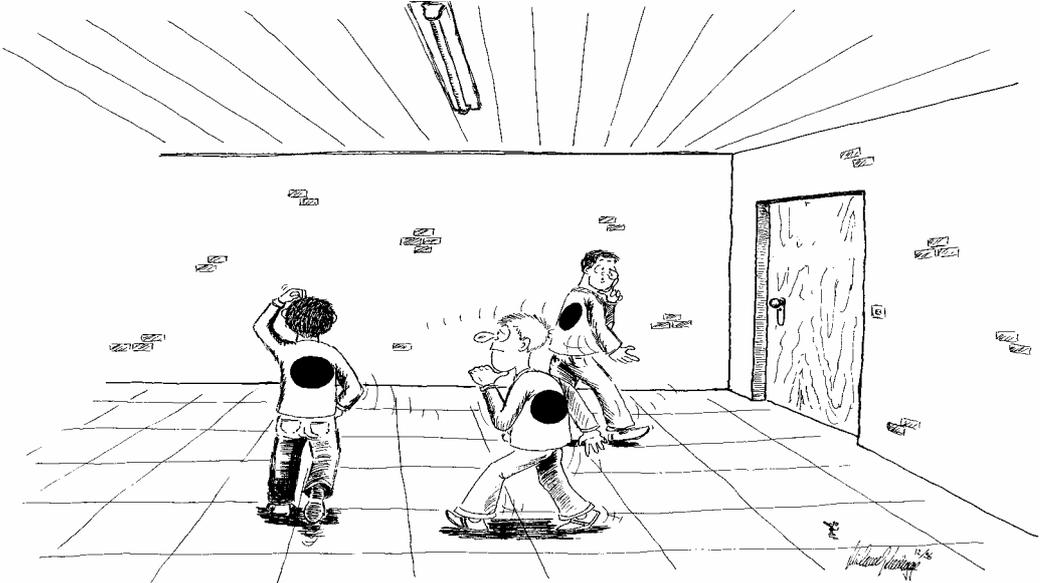
a) Description of the prisoners' dilemma

The warden of a prison summons three prisoners and tells them: "For grounds that I will not explain to you, I will grant one of you the chance to gain freedom today, which actually all of you deserve. You need to consent to an experiment in which you will have to solve a riddle. The first one to solve the riddle – by reflection or chance – will be set free immediately."

The prisoners consent without further consideration, as freedom is their utmost desire. Hence, the warden determines the following:

¹⁷ For an exhaustive explanation of the example, cf. Lacan (1986, III, 103 ff. and 1980, 365 ff.).

The prisoners are locked in a room, but are free to walk around and are able to see the others. Observers are placed outside on one side of the room and are able to watch without being seen. A guard is placed behind the door which is in one corner of the room. The warden approaches and says (cf. Fig. 2):



III. Time 3 (Truth)

- time passes by
- Conclusion 3: "I am black"
- I run
- suddenly everybody runs

II. Time 2

- duration of hesitancy "maybe"
- nobody walks out
- Conclusion 2: "nobody is white"

I. Time 1

- nobody runs immediately
- observing and setting up assumptions
- Conclusion 1: "there are not two white discs"

Fig. 2: Dilemma of free walking prisoners

"There are five discs, three black and two white ones. Each of you has one of them attached to his back, so you are unable to see your own color. The first one to tell the guard behind the door the color of the disc attached to his back will be released. If you don't know the color, don't address the guard. Your detention will continue as determined. Yet, by giving the wrong answer, you will double the length of your detention." All prisoners are given a black disc.

b) Solution of the prisoners' dilemma

The prisoners are given adequate opportunity to walk around and watch each other. The experiment already implies the prohibition to talk to each other, as they need to work against each other. The prisoners know that their detention will be doubled if they state the wrong color. Consequently, they strive for logical unambiguousness in order to draw the correct conclusion.

If one of them detected a white disc on each of the others' backs, he would immediately approach the exit.

As soon as he does so, the others will know as well. Given the case that one of them has seen a black and a white disc on the others' backs and perceives one of the others rushing to the exit, he will be able to deduct that the disc's color on his back must be white and will try to overtake the other prisoner.

Yet, if they all walk around and watch each other for a longer period of time then, by logically deducting, all of them should need to approach the guard and say: "I am black! I observed that the two others have black discs attached to their backs. If I had a white disc, either of them would have realized and rushed to the exit. This is what they would have thought: If I was white as well, the prisoner observing two white discs would have *immediately* approached the guard. Yet, this did not happen. Instead, everyone hesitated, so, the logical deduction must be that, firstly, nobody saw two white discs and also, secondly, that none of the others saw a black and a white disc which would have meant that he had to be black. Consequently, we all must be black."

While in principle all of them have equal chances, reality will show that the one equipped with a certain logical velocity and motor abilities will be superior to the others and therefore will win.

c) Truth in the context of indeterminacy¹⁸ and complexity

I will reflect on this example as well. Lacan describes the observed dilemma as a key scene of modern psychology. The interpretation will show that he opens a door for us to a world which is in better accordance with our understanding of truth during the process of observing such behavior than it is in the first example with the tied prisoners.¹⁹

Looking back on the first example, we can observe an important prerequisite for causal conclusions in the way the experiment is arranged: Prisoners A, B, and C can draw their conclusion one after another, i.e. each conclusion is logically based upon the preceding. Were the prisoners placed next to each other, it would be more difficult to perform the succession of the logical arguments. I was able to confirm this in a test with students which I conducted several times. The second experiment proved to be a lot more difficult than the first one because the social pressure induced the prisoners to take a guess rather than to logically conclude. For the following reflections, I would like to assume that our logical rationality is developed in such excellent manner that we are able to draw imperturbable and quick conclusions, even if we are in a situation as the prisoners of the experiment are.²⁰

Why is the experiment so difficult? First of all, the conclusions are not only tied to the logic of the observation of black and white, but also to the observation of the (mental) behavior of the co-prisoners. Consequently, the conclusions have become partly *psycho*-logical.

In order to secure the logical conclusion within the seemingly chaotic juxtaposition of the walking prisoners, time is used (constructed) as a variable which allows to draw conclusions about the probability of the discs' colors and will finally lead to logical truth. From an external observation position, i.e. from the warden's view, we instantly perceive that it is impossible to come to an unobjectionable logical solution of the problem. In the first example, the experiment had been arranged in such way that the logical conditions were gradually defined: in the beginning, the prisoner in the front knew that there were no two white discs because otherwise the prisoner in the rear would have known the answer; in a second step, he knew that the prisoner in the middle did not see a white disc because otherwise he would have known that the disc on his back had to be black. All conditions were set in an unambiguous, subsequent order.

¹⁸ The metaphor of indeterminacy refers to Heisenbergs well known indeterminacy principle. For a comprehensive elaboration of the principle of indeterminacy for the humanities cf. Reich (1998 a).

¹⁹ While I am partly guided by Lacan's (1986, III, 103 ff. and 1980, 365 ff.) reflections, I will ultimately develop an altogether new interpretation.

²⁰ Regarding a more specific substantiation of the logical figure and potential objections, cf. Lacan (1986, 105 ff.).

The second example prevents such order because the arrangement of the experiment prohibits that the prisoners talk to each other. Were conclusions verbalized, one of the prisoners would win instantly. Only external observers are able to realize everything at one glance. The prisoners perceive the others' hesitancy and their insecurity which altogether coagulate to a logical deduction the more time passes; thus, firstly: if nobody rushes to the exit, then the others do not see two white discs either; thus, secondly: given the case that I was white, then the others – who are black, as I know – would observe that nobody rushes to the exit which leads them to the only logical conclusion that they are black; and therefore thirdly: as nobody has rushed to the exit so far, although I have concluded all this – presuming that the others are logically able and quick in like manner– I can assume that I am black. If all of us hesitate and approach the exit only slowly, my conclusion turns into an unshakable truth.

In order to obtain this truth, three fractures of time are necessary. They can be observed by the prisoners themselves, as well as by external observers watching their reactions. The first fracture excludes a quick solution: There are no clearly discernible two white discs. The second fracture signifies the reciprocal doubt which follows from the first fracture and also helps to continue the reasoning. The respective person concerned can be either black or white, but the others' reactions are still as insecure as mine. Black and white are both logical possibilities at this stage, while the only impossible solution reads: two white. Yet, I am not the only one drawing these conclusions: This is an interactive game. Were I white, the two others would see a white and a black disc in each case. Consequently, they need to conclude that – were one of them white – someone would have already rushed to the exit. As this has not happened so far, they know for sure that they must be black. But still nobody rushes to the exit. This is what affirms the third fracture: All three prisoners must be black, because otherwise someone would have rushed to the exit before.

The time they need to understand while testing their constructions can be perceived in the prisoners' body language and in their looks. The prisoners' largest difficulty lies in the determination of the time limit which reflects the respective logical fracture. By watching the others, each subject tries to assure itself of its color and can therefore be regarded as its color's own constructor. It will only come to know its color if the others have not already hastily concluded their part in this mutual game. Anyone trying to simulate the game will realize that only secretly watching the others will lead the logical time to a warranted assertibility (as Dewey calls it) of black and white. Only by systematically referring to the other prisoners, this certainty can be anticipated. Although it can be chronologically measured, it is not based on the ticking of the prison's clock, but on the continuum of the self and distant observation. This offers the only possible solution for the experiment.

The face of indeterminacy becomes apparent in the second experiment. The subject interferes with the logic by her/his doings and articulations which actually enable the problem's solution at all, which is why the truth which s/he discovers can not be separated from the doings which testify of it (cf. Lacan 1980, 367).

Although it must fail from a logical perspective, it, nevertheless, can be achieved in a *psycho*-logical approach. In noting this, we can detect a fundamental change of logic: In the first prisoners' dilemma we are able to define a logic which seems to be universalizable during constant conditions, because logical causality forces us into the solution as constructed here. In the second example the warden has created a condition which cannot be solved by logic alone, but can only be solved by *psycho*-logical means. The situation appears to be unfocussed and complex at the same time from a psychological perspective. The indeterminacy and complexity can be settled by a logical interpretation and the individual intuition which is focused on the passing time. When conclusions have come to an end and the anticipated certainty has formed, the decision, which has to be made, is finally objectified. Play settings offer the chance to observe that participants feel forced to rush to the exit because of the others' reactions, although – due to lack of logical velocity – they actually have

not drawn an unambiguous conclusion. Presumed that all prisoners are in possession of the same motor abilities, we can assume that they will reach the exit at more or less the same time. Having arrived, the act of concluding is deconstructed, that is psycho-logic turns into logic. Likewise, the psycho-logic appears to be unambiguous, objective, reductive and intersubjectively repeatable in the clarity of its reactions. The aspects of hesitation and haste suddenly become logical categories, emotions connected therewith are subjected to logic and seem to represent therein the warden's scientific expectation: unambiguousness. As we are representatives of such knowing control, it also represents *our* scientific expectation.

Yet, such clearness, as performed by the three prisoners of our example, is already a construct. The course of time that is needed to understand may vary, because the subject's inherent time within the process of understanding is interfering. By repeatedly performing the situation, I was able to experience that – by logically reconstructing one's own movements with the help of others – the fractures of time could be transferred from guessing to an obligatory logic only with hindsight. I was able to observe in several simulations of the game that the participants, although they were rushing to the exit, were unable to account for the solution they had come to. They had just guessed. As there were three black against two white discs, they tended to name black more often. Only after the subject has realized the symbolical logic, that is, after it has transferred it to the language of its own psycho-logic, only then will it be able to judge its own imagination in discussions with the others more clearly. If the experiment is repeated, the correct solution is – after a very short period of mutual assessment – always concluded much quicker than before (even if the conditions of the experiment have been varied).

Hesitation and haste are mechanisms that apply in a different extent to the individual subjects and cannot be transferred equally to other situations. Only by abstracting hereof, we are able to achieve a relative unambiguousness of our experiment.

From a logical perspective, our solution must be regarded as paradox. By introducing the factor of the time needed for psychological conclusions, we achieve a truth that differs from the one of the first, causal experiment. Truth in the form of psycho-logic forestalls error, as expressed by Lacan (1986, III, 118). It is a subjective act of certainty, based on the condition that it is tied to the system of mutual observation. And are we not puzzled in the moment of realizing this prerequisite? While observing this experiment, are we not, at the same time, observers which subjectively draw conclusions and deduct certainties from conclusions which are nearly never as clear as those of the tied prisoners? Science, we could try to explain, is a place where we are 'tied' and where things are reduced to the smallest observable units in order to gain answers of a first order logic. This is how I would like to define the act of concluding within the chrono-logic of the first experiment. Yet, psycho-logic contains a second order logic, because the process of objectifying which is implied therein can only be created in the movement and can only be tied to subjective moments of the moving. This requires a co-logic, because the logical conditions are only connected to the situational conditions of the acting persons in the respective situation. Time is revealed as an important factor in our example, because, for once, it is the measuring instrument for action and reaction par excellence, but also because other observable states, i.e. the strength and quality of a sensed emotion, may possibly occur. Such emotions also show a time component, but it may be perceived as rather secondary in the moment of sensation. I would like to emphasize that the portraying of the situation in our example as a black and white issue is primitive in its experimental design compared to the normal behavior of human beings. Yet, at the same time, it is instructive and can be regarded as exemplary for behavioral science, because already the most primitive example displays the complexity of a second order logic which alone enables us to design adequately subjectifiable as well as objectifiable constructions of a scientific

reality.²¹ Likewise, in the experiment of a second order logic we are left with a dilemma which, generally, needs to remain the dilemma of every quest for truth. We arrange a research field which remains restricted – as the prison – and describable in its conditions because it is observable in a precise manner. If we regarded our whole world to be like the prison of the example, the interdependency chains of its population would be too complex to precisely observe, for instance, in how far the chrono-logic will lead us to anticipated certainties of an unambiguous nature. Nevertheless, our simple example reveals that human beings obviously dispose of abilities to endure such experiments. Consequently, we can draw the following conclusions from the experiment:

- There are scientific solutions in experiments which cannot be sufficiently constructed only in a rational way. Such solution is described in the second prisoners' dilemma. But even here we need to narrow the problem down in order to solve it. While conducting such restriction, we may not simply eliminate the narrower logic of observation. We are already deceived by our world of definitions which relates to the unity of the signified, but what is more, the laboratories of our scientific world and most of the experimental test designs are generally designed to take indeterminacy into account. Damage is not caused in every case, provided that the level of abstraction and the content of the gained information remain arguable. Unfortunately, this is not the case if the aspect of indeterminacy is not discussed.
- In the course of our lifetime, we comprehend the psycho-logic inasmuch, as to put ourselves in a position where we assure our self in an discernible quality by way of looking at others. At the same time, we strive to avoid achieving only uniformity therein, because within the psycho-logic, we are distinguished with respect to individual perception, emotions, quickness of apprehension and many other aspects. This quality is definitely more than just being able to conclude whether one is black or white. Yet, it is already revealed in this simple thought experiment that there is more to all experiments examining the human behavior than just a direct logic of observation. Something new, namely a systemic logic, a logic of relationships or psycho-logic, is added. This systemic logic is behavior-related and psycho-logic as well as socio-logic in the broadest sense.
- A further difficulty is, that we realize the logic of relationship's or psycho-logic's logical implication only after having devoted ourselves quite some time to the narrower logic of observation. In other words: Before being able to acknowledge the limits of complexity for the description of behavior, I need to have participated in closer attempts of behavior descriptions in order to determine the inherent risks of simplification. At the same time, I therewith acquire the relevant terms as used in the systemic logic, even though they are provided with new aspects of denotation. The crucial point is that, during the test, the experimenter systemically reflects himself. We need to reflect the indeterminacy caused therewith – a phenomenon which natural scientists have already come across in strict experiments, as described by Heisenberg – in order to perceive the experiment's alteration caused by the co-operation of all people involved.
- Within the logic of relationships or psycho-logic we must not commit the error to mistake a human being for a mere thing or for an isolated object within an unambiguous description of objectivity. From scientific efforts which follow such logic, we need to demand the following:

²¹ Lacan describes the logical possibilities for a realization of the experiment with more participants (1986, III, 119 f.). Yet, the conditions for misgivings are increased with every participant and, consequently, the chronological objectification will be more difficult to understand, the more participants are included in the experiment.

- In interaction subjects can come to statements about themselves, the others and objects involved, without exactly knowing what the self, the other or the object completely is in the sense of an ultimately determined reality. From a psycho-logic and systemic view, we only know who we are, as well as who we are not (in a chronological, spatial, social etc. aspect) by excluding other views and possibilities (cf. in more detail: Reich 1998 b).
- Such knowledge requires an acquisition of knowledge; the more complex a given problem situation which is experimentally researched, the more complex knowledge needs to be designed in order to exhaust all potentiality in a maximum multimodal way.²²
- We need to realize that, in a certain way, we are prisoners of an observing situation, like the prisoners of our example. This is still valid, even if we manage to gain the position of a meta-observer (like the warden) or the position of an observer of the observer, because, ultimately, there will never be a final, closed, or ultimate observation position (cf. Reich 1998 a, Ch. 1).
- Even if we comply with certain logical explanations and sense experiences as well as their interpretation in time and space, like all other observers, this does not exclude the possibility that we may differ in speed, range and quality. Here, we reach the limits of conveying our certainty to others.²³
- The constructive stock of our explanations, which constructs a world for us and for others, needs to remain negotiable for mutual utilization, although this utilization may be restricted to a very small person subgroup.
- Our constructions are subject to continuous examination by other observers. As a rule, we adjust our observations to others which, again, always means a regulation of our constructions.
- The logic of time not only extends into our cognitive sphere or our reason, but also addresses us as an entire person, including our emotions and physical mechanisms. Consequently, we will never be able to achieve a pure, de-humanized logic when trying to explain ourselves.

3. The freedom/domination problem in the second prisoners' dilemma as a special case

Finally, we need to take a further step and also question the logic of relationships or psychology. What would actually happen if the prisoners, while mutually assessing each other, looked at the others' colors, approached each other and started a discourse in which they simply ignored all instructions? They would then, in the most easy manner, be able to determine the colors on their backs. They only needed to agree to do without a winner and, therefore, would be able to confront the warden with an – unexpected – paradoxical situation, offering a solution with equal rights for all participants.

In the social sciences, such form of communication has been denoted differently, according to different approaches. Habermas, for instance, speaks about an emancipation from domination which comes into being if all speech partners are able to equally enter into the discourse

²² In the same way as Howard Gardner (1993) speaks about multiple intelligence which has to be considered for learning (with respect to the consequences, cf. Gardner 1991, 1999 a, b), also, and in particular, experiments need to be developed with regard to the depth and width of science- and knowledge-related possible connections. This is often prevented by time and financial pressures in research.

²³ These contexts have been accentuated in particular by authors from the spectrum of poststructuralist phenomenology. Cf. Reich (1998 a).

without claiming to have dominant power over the others. This can be regarded as an ideal speech situation. The warden of our example has tried to exclude precisely this situation by adjusting the prisoners' interests in an antagonistic way.

Such ideal speech situation can be produced with regard to the contents if all prisoners neglect their self-interest in liberation and, instead, try to come to a solution with equal rights for all of them by speaking truly and coming to logical conclusions. Science emphasizes such speech as a concept which retains a possibly free access to knowledge. Yet, scientists have always been presupposing the avoidance of self-interests and the wish for a general well-being in order to enable the probability of the situation. But how probable is this in our current world? We always need to consider this particular situation of freedom from domination as well as our interest in the general well-being, before our speech community's ideality can set in. In my eyes, the second prisoners' dilemma, as a metaphor, comes closer to the actual everyday life of our times, because it displays people that are free to walk around *and* shows them in predetermined structures. These are circumstances we all know. Yet, we also experience that explanations from a scientific-causal perspective alone are no sufficient help in such structures. We are confronted with an opposition of relationships as well as of power which obstructs the ideal-type speech conditions from the start. Here, the assumption that people detach themselves from their interests, can only be imagined as a special case in human behavior.

How could the prisoners manage to detach themselves from such a situation? They would need to work themselves loose from the clash of interests and – again ideally – enter into a meta-communication, i.e. a communication on the prerequisites of their communication. They could then pass over from a first order solution to a second order solution. Hence, what do they need to realize in this process?

They would need to understand that their existing approach to the problem produces a linear pattern and is arranged in a causal mode according to winners and losers. To be more precise: They need to realize that there will be definitely only one winner and they need to become dissatisfied thereupon. They might be induced to do so if they know the concept of the freedom/domination discourse. Yet, they also may become suspicious and deceive the others just on account of this utopian character of such discourse. Only trusting the joint new solution will lead them to their targeted goal.

At the same time, they need to detach themselves from the chains of the first order logic, i.e. they need to leave the understood, the expected, and the pre-structured behind and come to terms with themselves. Although others may perceive their acting as spontaneous, paradoxical, and unexpected, they, nevertheless, will find self-confidence therein, if all of them keep to it. But here we can observe the dilemma of such life-worldly demands: One will only keep to this way of acting if the vision of a joint gratification, respectively a joint success (a benefit of pleasure of whatever nature) is at least imaginable. If this is not the case, such acting becomes less probable. The warden of our example and his demands somehow coincide with economic and social expectations in the capitalist society: Not everybody is supposed to be able to win in equal measures. The determination of the winner seems to be controlled by an invisible hand. The largest contradiction of the freedom/domination discourse is, that the ones expected to conduct this discourse, need to comprehend it beforehand. This, again, presupposes their acquirement of a long list of school graduations and selective exams in order to put them into a position in which they are actually able to interpret the difficult texts on this topic. After having been trained for years to strive for an individual success over others, they are now supposed to waive their own life-experiences due to the understanding of an ideal.

Further, they must not search for chains of cause and effect – like: who has been longer in prison, who is guilty and who is not, who is older or younger – in order to come to a solution, but need to unconditionally refer to the here and now.

Once achieved, their approach to the solution will be led out of the given dilemma, the vicious circle of the experiment's design, and will be perceivable as something new, as a new logic, even for us as external and distant observers. Yet, this requires a revolution which appears to be impossible from a life-worldly perspective: We need to doubt and correct the structure itself. The structurally preceding risks, like the threat of the doubling of the detention in our example, have to be ignored. Ultimately, this means the removal of the prison and its warden. According to Foucault, who has directly traced out the power within institutions of modernity, the critical demand shall be that such power-resolving attempts are desirable. They are regarded as necessary within a democratization which – in the sense of a claim for freedom – aims at equality of relationships in order to delimit hegemonic power²⁴ or to restrict the makeup of monopolies or centers of power. But, on the other hand, they are unable to dispose of the power-problem by themselves. There are several reasons for it:

- The stronger the subjects' autonomy is emphasized, the larger their *mutual* free space grows. In turn, such reciprocity causes different situations of interest, motive and signification and, thereby, a space for mutual powerful demands. Ideally, demands for power remain in a negotiable balance, yet, power will not vanish only by restriction. At most, it will be reduced.
- Due to the rules of reduction, a reduction of power will already create new coherences of power. With regard to a potential agreement, the prisoners of our example could have negotiated, for instance, about who was to be freed. Even if they acted due to deeper insight, this would be bound up with the creation of power (respectively powerlessness) of one prisoner towards another. Alternatively, they would have needed to abolish the prison, including its administration. Yet, even this would have required the use of power against the warden and his wards.
- Consequently, it seems to be reasonable to restrict the structures of power in order to avoid the risks of a too heavy oppression. But does not the development of cultures lie in exactly such processes that make structures grow more complex and finely woven in order to correct the individuals' life-world by acting as a powerful background? Can we regard the second prisoners' dilemma as the dilemma of socialization in post-modernity *par excellence*?²⁵ Only the prisoner able to see through and realize the fractures of time according to his own interests, his knowledge and velocity in acting, will finally emerge as winner.
- In doing so, the subtle depths of the powerful structures are never absorbed in the ostensible surface of the acting subjects. The self-observer, as well as the distant observer, perceive different semantic horizons of power. The largest liberties of post-modernity are built on the basis of very tight life-world structures: money, institutions, property and production rates, roles and *habitus*²⁶ – or however the observing positions are supposed to be set – structurally regulate the possibilities of actions, which, from a narrower perspective, appear to be free, informal, creative etc. Today, we therefore particularly need to assume both perspectives in order to think both views in a conciliatory way. Only by doing so, we will succeed to decide in an adequate situational manner how to use significances and what we want to, respectively what we can settle upon.
- While analyzing such surfaces and depths, self and distant observers are often unable to reach a consensus in their observations. Self-observers readily hold out in the imprisonment of the habitual. When, as a distant observer, trying to force my knowledge

²⁴ Cf. hereto also the continuative theories by Laclau and Mouffe (Laclau/Mouffe 1985, Mouffe 1997, 1999).

²⁵ Cf. hereto in particular Bauman (1995, 1996, 1997, 1999).

²⁶ *Habitus* is the term used by Bourdieu; it seems to be quite similar to habits in the sense of Dewey.

on them, I will experience a quality of imprisonment, which one can grow fond of: It assures the acting which develops from a habit, a familiarity, and an order which can hardly be resolved. The most fundamental insight in psycho-logic we have noted, is, that the latter can only be perceived and then be realized by the subject itself. Yet, we cannot implant it – in the sense of a narrower observation logic – into the heads of others. So, with regard to interfering powers, the different perspectives with their different situations of interest and motive challenge an approach which, again, would try to define the necessary degree of freedom from domination.

4. Scientific truth and context

I would like to sum up our three examples:

- The first example reveals familiar scientific logic. One thought is, successively as well as simultaneously, concluded from the preceding by clarifying terms and restricting conditions in order to achieve unambiguous statements. In everyday life, we are used to apply this logical approach to the objects and technology which we are confronted with; we also know it from our behavior when being sanctified by legal norms and regulations. With regard to science, this logical approach seems to symbolize progress par excellence.
- The second example shows that we build up complex relationships to others whenever we draw close to everyday life. Although we still apply the first logical approach, we simultaneously need to pay attention to our position as observers of the others respectively observers of ourselves in order to get along. If we want to integrate introspection and external observation in a reasonable way, we need to understand that socialization, interaction, and communication are central ideas which signal that, in the interweaving and interdependency with others and in the chains of action connected therewith, we can no longer make do with the attribution of simple, reifying words.
- The third example is a special form of the second example's solution and displays that there is also a meta-solution to the second logical approach, if only we abandon the traditional paths of psycho-logic and try something truly new and revolutionary.

In scientific work, it is common to distinguish between so called *hard sciences* and *soft sciences*.²⁷ According to Heinz von Foerster: "*Hard sciences* are successful because they deal with *soft problems*, while *soft sciences* have to battle because they have to deal with *hard problems*." (von Foerster 1993, 161) *Hard sciences* are concerned with hard facts, with technologies and their transformation, and also with the so called material progress. *Soft sciences* are concerned with the human factor, namely in fields in which this factor cannot be deducted unambiguously and sufficiently exact from mere material or physiological circumstances and, therefore, can not be determined by everyone in an equal and complete manner. This distinction seems to coincide with the two examples, as discussed above.

The example of the tied prisoners can be regarded as a typical metaphor for *hard sciences*. They are oriented in a strictly causal way and informed by linear and chronological research. Their verifications are intersubjectively reviewable, ideally, they should be experimentally verified. The potential influence of a logic of relationships or systemic logic, as displayed in the second example, is regarded as a preferably excludable failure. Finally, with reference to

²⁷ The distinction made in English between *hard* and *soft sciences* equals the distinction made in German between natural sciences (*Naturwissenschaften*) and humanities (*Geisteswissenschaften*).

the metaphor of melted tin, the latter shall not be melted according to the relationships of the researchers or technicians, but according to the unambiguous relevant variables of the environment which exclusively refer to the elements of the experiment.

Although this attitude has proven meaningful within the *technosciences*, one must also note that this very narrow view has caused problems in the co-constructions of man, machine and environment. By focusing solely on the feasibility of the experiment, researchers were often blind to what constructions and productions meant for human beings and their environments. These co-constructions, i.e. the changes caused by the constructed and produced as a formed momentum for human beings and their environments, have an impact and a significance which goes beyond the limitedness of the experiment. The experiment of the first atomic explosion can be regarded as particularly meaningful: It displayed that not everything brought about by the *technosciences* is at the same time equally good for man. This, consequently, proves that Heinz von Foerster's statement needs to be extended: It would seem to be more precise to say that the *hard sciences* will cause further extensive *hard problems* if they only intend to solve *soft problems*. How can science avoid these 'home-made' *hard problems*?

The distinction between interactional and transactional, as made by Bentley and Dewey in "Knowing and the Known", aims at a solution of this question.²⁸ From their perspective, the mere reciprocity which, here, is designated as interaction, is not regarded as sufficient in order to form a comprehensive scientific understanding. Transaction designates a form of scientific comprehension which not only integrates the scientific context with the interacting persons and their environments, but also considers in how far the experiment can be determined by the context and, vice versa, in which way the experiment may change the context (including man and his environments). In this respect, we could state an ideal of scientific work according to the first prisoners' dilemma, which presents the latter as a too narrow imprisonment. All sciences operating in a narrow, causal model, are challenged to fully face the contexts of truth. The question remains, whether this has to go as far as in the *soft sciences*?

Other than expected, the second example turns out to be less prototypical for the *soft sciences*, which is due to the fact that many researchers in the *soft sciences* are attracted by models of the *hard sciences* in order to participate in their success and social approval. This often leads to a problematic simplification of their research. In fact that the causal scientific approach can only find limited application in *soft sciences*.

In order to illustrate this idea, I want to recur to the second example: The prisoners' game takes place in a circular way. Only by observing the others' behavior, they are able to systemically deduct the truth of their (own) color, only by comparison with the others, they can after all achieve this truth. Even beyond the narrowness of the prison, this provides us with a simple scheme of human relationships which illustrates that measure of confinement signifying personhood: to be interwoven with other people in a circular way and to be able to situate a thing like truth – and many other things in life – only within this interweaving. Interactive constructivism calls the place where this can be observed: lived relationships.²⁹ When observing this form of relationships, we follow rules which can be distinguished from the classical causal confinements as empirically stated by us in the first prisoners' dilemma:

- rules are always (in a linguistic, acting etc. manner) tied to the others from which I am discernible or which I talk about;
- hence, they are circular. The imagined linearity and causality of the narrower reality of relationships can be regarded as an attempt to reify, to form as a monologue, and to reduce

²⁸ Here, the term 'interactive' is rather related to the reciprocity between objects and persons, while 'transactional' is related to a reciprocity with an implemented joint development. The Cologne approach of interactive constructivism uses *interactive* always in the sense of *transactional*.

²⁹ For a more detailed reflection of the concept of reality of relationships as used here, cf. Reich (1998 b, Ch. 3).

the inherent indeterminacy by de-subjectifying it in order to gain an overview, unambiguousness and a scientific method;

- this, again, enforces, by being reductive, a pseudo-world of true knowledge which has robbed itself of its own indeterminacy and, therefore, will systematically produce new areas of indeterminacy, e.g. oppositions between theory and practice, between science and everyday life, between objectivity and subjectivity, etc.;
- the scientific coverage of a reality of relationship beyond such reductions results in the problem of an accessibility of observations, but scientists hasten to emphasize the potential danger of losing all their statements' precision and truth within their own indeterminacy.

By taking the problems of the soft sciences seriously, it can be distinctly observed that they need to considerably extend their methodical spectrum in order to come to adequate experiments as well as to a comprehensive interpretation of the latter. Such interpretations need to adequately reflect the complexity and indeterminacy of the studies.

Insofar, *soft sciences* are indeed concerned with *hard problems*; in addition, their work is not particularly facilitated by the (qualitative) methods which are applied in order to meet their objects. If the *soft sciences* operate with terms that objectify our observations, i.e. whenever we use the form "This *is* a child that" or "This person *shows* that ..." or "True knowledge *is* ..." etc., then we have to take into account an extended context which is less obvious and unambiguously definable than in the *hard sciences*. Context, in this case, means that an external observation will in no way be sufficient. All experimental regulations show complex references and a multi-modal connectivity, because the decision for an unambiguous and reductive experiment is, due to the (actually necessary) admission of an interactive research field, no longer simply feasible and meaningful. Crucial questions in these research fields are, for instance: In experimental regulations, do we still see what is going on behind the scenes, where an invisible interweavement coherence between the individuals ties them together, detaches them, distinguish them or makes them develop in their interactions? Are we in a position to sufficiently investigate the chains of interdependency that are associated with this? In order to create an example for the *soft sciences*' complexity, we merely need to imagine the reconstruction of our own family history. Very quickly we will reach the limits of complexity. What is more, I provokingly dare allege *in principle* that we will not even manage to reconstruct our *own* childhood and youth situation as it *had been*. And who – and from which point of view – should be in a position to unambiguously determine how things had *really* been, if this is already perceived in a differing manner by us (in the various stages of life), due to our own, subjectively different observation positions as time goes by? When interacting with others – which is what we always do as a matter of principle –, when communicating or when narrating our own history from various perspectives to various people in various contexts, we are producing a very complex situation. This situation is so complex, that every concentration on an *individual* problem that we want to experimentally research, subsequently necessitates a reconstruction of, at least, parts of the context in which this research is placed. This is fundamental for an observing position which claims to be logical in a systemic way and wants to face the menace of a dogmatic and partial approach. From a scientific perspective, scientific introductions are regarded as problematic as soon as they establish specific terms which induce us to say that a certain thing *is* this or that. Definitions like "a good person *is*", "knowledge *is* a procedure that", "true knowledge *is* displayed in steps which ...", etc. can, on one hand, be regarded as well-meant assistance for alleged beginners with respect to human logic, but, on the other hand, they leave us helpless when concealing the interdependency's background and lead us astray by relapsing to a too narrow logic. They may suggest to the observer that there are advisors at secret places who are able to disclose how true knowledge about relationships can be completed, or how to organize the perfect

learning, what a normal childhood development is supposed to look like and who should be responsible for this or even who should be in charge of controlling such procedures. Here, the context, which always needs to be taken into account with respect to questions of truth, is neglected in a dangerous way. This will result in a simplifying view on the world.

Hence, the *soft sciences*, contrary to the *hard sciences*, are confronted with a different kind of problem. While the *hard sciences* sometimes neglect the context and often lack a transactional comprehension, the *soft sciences* succumb to the complexity of contexts and easily prove to be helpless when it comes to achieving unambiguous statements. This concerns particularly the attitude towards experiments. They are often given up hastily because nearly none of them complies with the necessary amplitude of research on the object.

Educational research can be regarded as a good example for the afore-said, as educational researchers have discovered a lot about how we can learn more effectively. This is in particular valid for those educational researchers working as teachers in the classrooms: Their empirical horizon evaluates every theoretical pretension in a practical way. Nevertheless, they are generally not accepted as educational researchers and are regarded as dead capital by the actual educational research which, itself, takes place at universities in a secluded manner. Here, researchers often rightfully deplore that they are only provided with small budgets for their research, for only a short time, and only in limited fields. This is what the hard sciences teach us: In order to conduct a significant experiment, it is necessary to combine educational research and practice as shown by Dewey in “School and Society” (MW 1). Further, educational research needs to experimentally secure the practical proof in school and to reflect the processes of a successful and effective learning. Yet, this is exactly the soft sciences’ dilemma: A project like this is quite large-scale. Not only does it require an enormous co-ordination of experimental efforts, but also the meaningful interaction of many people. Further, it requires support on the part of politicians and partly investors: Being able to get hold of such support seems to be a nearly impossible task, in particular with regard to the struggle for funds in times of globalization. This is partly because politicians and investors perceive themselves as successful within the existing school-system and therefore naturally do not feel an existential need to change the latter. As a side-effect, the best schools are being supported by investors in order to create private schools for their own offspring.

The relationship of context and truth proves to be difficult according to my analysis. We are able to observe a strong context oblivion whenever context presents itself most unambiguously, i.e. in the narrow causal truths of plain hard science or technical experiments. Whenever it is particularly incorporated, it appears to be rather obstructive to the progress of experimental work, because contextual doubts bring the process of research to a standstill. Hence, having observed this analysis, we, in our capacity as researchers respectively recipients of research, are required to consider at least three reflections which I comprehend as a kind of minimum requirement to science with respect to context and truth discovery:

- (1) Truths develop from contexts and contexts necessitate truths; consequently, we need to take contexts more seriously in our field of research in order to avoid simplifying truths, but we also need to take the thereby constructed truths more seriously by conducting real and specific experiments. This is a basic requirement which every scientist should strive to fulfill. It should also be a recurring source for critical self- as well as external reflection with respect to science.
- (2) Interdisciplinary research is one possibility to come to terms with experiments, as well as with an extended understanding of contexts within specific thematic focal points which go past subject borders. In particular, the sometimes narrow-minded borders between *hard* and *soft sciences* prove to be increasingly obstructive for scientific development. Yet, as nobody is able to gain an overview over all research fields, team-oriented co-operation is needed. Strictly speaking, this approach to research should be a rule rather than the exception.

- (3) Because transdisciplinary research is not limited to specific topics, it can encourage to reflect on the possible application of entire methodical areas or perceptions of other disciplines to one's own discipline or within interdisciplinary projects. Such contextual reorientation offers a chance to break away from usual ways and to innovatively question one's own research field. Yet, this is precisely why research also needs, apart from the proof of its efficiency, an adequate quantity of time and funds in order to independently conduct experiments. The less this is achieved, the more context oblivion will enter into science.

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