

# IS GAME THEORY COMPATIBLE WITH CLAUSEWITZ'S STRATEGIC THINKING?

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Although game theory is a rather young area of science, it is already well established in the field of mathematically oriented decision-making techniques. Initially its findings were mainly aimed at describing and explaining economic processes, later however these concepts of thinking were also applied to political and military-strategic problems. The development and implementation of the flexible response nuclear strategy was based on game theoretical calculi, but it has also been applied to arms control, as well as confidence and security-building measures.

In Clausewitz's broad array of works, including his opus magnum, the book "On War," one can find a great deal about strategy. For a basic understanding of his arguments, it is important to keep in mind the fact that he has certainly not written a doctrine, but strives rather to give a guide on how to think: "Given the nature of the subject, we must remind ourselves that it is simply not possible to construct a model for the art of war that can serve as a scaffolding on which the commander can rely for support at any time."<sup>1</sup> Clausewitz's main concern, therefore is to train the strategic spirit, and not to try to press a commander into a tight corset of rules. To do so he describes the basic, permanently changing nature of war and he shows the instruments of analysis, which should be taken into consideration in a concrete strategic situation.

Using this as a point of departure, the subsequent contribution<sup>2</sup> tries to deal with the question of whether a strategic calculation, based on game theory, can be derived from Clausewitz's (philosophical) concept. If this should prove to be the case, then game theory must certainly become a further element in the toolbox of Clausewitz's instruments of analysis.

The origin of a systematic development of game theory is connected with the names John von Neumann and Oskar Morgenstern. In 1928 Neumann

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<sup>1</sup> Clausewitz, Carl von 1989. *On War*. Translated by Michael Howard and Peter Paret. Princeton University Press, p. 140.

<sup>2</sup> The following is based on the author's thesis "Clausewitz' Verständnis von Strategie im Spiegel der Spieltheorie" (Berlin 2012).

published an article “Zur Theorie der Gesellschaftsspiele”<sup>3</sup> and formulated the basic thoughts to such game situations in which the outcome of the action of one player is directly dependent on the intentions of the other protagonists. Together with Morgenstern he wrote a book titled “Theory of Games and Economic Behavior” (first edition in 1944), which is considered to be the very starting point of this area of science.

The overall purpose of game theory is the description, analysis, and resolution of such decision-making situations where the individual options and alternatives of several participants (players) clash, and the consequences of each of these courses of action are in an interdependent relationship. Between the choices, there exists a system of dependencies combined with mutual interference<sup>4</sup>. The emphasis of the research is therefore placed on decisions made in social situations where the participants have conflicting interests, or at least a mixture of common and conflicting intentions.

To demonstrate its principal way of thinking, let us take a look at a classic example of game theory, the so-called prisoners’ dilemma, which shall illustrate its procedures. This example is based on the following story:

Two suspects are apprehended and separately interrogated. If neither confess to the major crime they were apprehended for, both will be charged with minor crimes, and then convicted. If both confess, both will be convicted of the major crime with a recommendation of leniency. If one confesses while the other does not, the squealer will receive a suspended sentence; the other will be convicted and receive a full sentence. In detail the offer of the prosecutor is as follows:

- if both confess, the official imprisonment of nine years will be reduced to six years;
- if only one confesses, while the other does not, the first will get one year, while the other will receive nine years;
- if neither one confesses, a prison sentence of three years for each of them will be the consequence.

Following this discussion there is no possibility for the two offenders to get into contact with one another and to coordinate their behaviour (solitary confinement).

<sup>3</sup> **Neumann, John von** 1928. Zur Theorie der Gesellschaftsspiele. – Mathematische Annalen, Band 100. Berlin, S. 295–320.

<sup>4</sup> The essential difference between this and classical decision-making techniques (“Operations Research”) is that these are focused on only “one” decision-maker, who will optimize his objective function in a given set of conditions.

In the light of the foregoing, a matrix can be generated (Figure 1a), which is to read in the following way:

- if each of the four fields is fixed, what would happen to both offenders, based on their combined behaviour?
- the left figure always represents the time of imprisonment for  $a^{(1)}$ , the right figure is consequently the result for  $a^{(2)}$ ;
- a negative algebraic sign indicates that imprisonment means the loss of freedom, so in this case  $-1$  is better than  $-9$ .

|                    |                  | OFFENDER $a^{(2)}$ |           |
|--------------------|------------------|--------------------|-----------|
|                    |                  | does not confess   | confesses |
| OFFENDER $a^{(1)}$ | does not confess | -3; -3             | -9; -1    |
|                    | confesses        | -1; -9             | -6; -6    |

**Figure 1a.** Prisoners' Dilemma

In order to avoid the use of negative figures this matrix will be transferred to another one (Figure 1b), in which the figures reflect, for both offenders, the gain of freedom they can achieve with regard to the maximum of punishment of nine years.

|                    |                  | OFFENDER $a^{(2)}$ |           |
|--------------------|------------------|--------------------|-----------|
|                    |                  | does not confess   | confesses |
| OFFENDER $a^{(1)}$ | does not confess | 6; 6               | 0; 8      |
|                    | confesses        | 8; 0               | 3; 3      |

**Figure 1b.** Prisoners' Dilemma

(By means of this linear transformation we have again attained the normal cardinality without having changed the basic structure of the problem<sup>5</sup>.)

Keeping in mind the offer of the prosecutor, the two offenders can now consider the following strategies:

- for  $a^{(1)}$  the strategy to confess is better than to not confess, because whatever  $a^{(2)}$  decides, in any case  $8 > 6$  respectively  $3 > 0$ <sup>6</sup> will be the result for  $a^{(1)}$ ;
- for  $a^{(2)}$  to confess is also more favourable than to not confess, because whatever  $a^{(1)}$  decides, it follows that, in any case  $8 > 6$  respectively  $3 > 0$  will be the result for  $a^{(2)}$ ;
- so, from the rational point of view of both of the offenders, the strategy to <confess> is the only reasonable solution since the result of this strategy is that for both, three years will be suspended from the maximum of punishment of nine years<sup>7</sup>.

This combination of confess/confess is self-stabilising because neither of the players benefits from unilateral deviations in their decision making<sup>8</sup>. This state of affairs is called a Nash equilibrium, named, in honour of John Nash, who discovered this principle of mutual best response in 1950<sup>9</sup>.

This solution concept, the Nash equilibrium has found a wide range of applications as it is also applicable to situations with more than just two players, and also for situations where there are more than just two options. However, there are some difficulties. It is perfectly possible, for example, that there can be more than only one Nash equilibrium in a game; this will cause a selection or coordination problem. Moreover, the prisoners' dilemma is a good illustration of how the Nash equilibrium is not necessarily the best solution. For instance if both suspects agree to not confess, they could gain six years of freedom each (instead of three years in the equilibrium). However, as this combination offers a deferred incentive to deviate, it cannot be stable. This means that the Nash equilibrium and the Pareto efficiency are not necessarily identical.

<sup>5</sup> For a mathematical point of view a value of nine has been added to each number; according to the rules of addition of matrices, this does not change their structure.

<sup>6</sup> In the nomenclature of game theory this is called a dominant strategy.

<sup>7</sup> This solution, by the way, would not be different, even if both would have had the opportunity to communicate before their decisions!

<sup>8</sup> For  $a^{(1)}$  this would mean a deterioration of  $3 \rightarrow 0$ ; for  $a^{(2)}$  the same would apply.

<sup>9</sup> In 1994 he was awarded the (Nobel) Price in Economic Sciences for his pioneering analysis of equilibria in the theory of non-cooperative games.



The possibilities of game theory to deal also with military problems was recognized rather early – mainly in the USA. In the 1950s<sup>13</sup> fighter-fighter situations and anti-missile defence systems were already being analysed on the basis of game theory, as were submarine manoeuvres. Colonel Haywood (US) was the first to try to apply game theoretical thinking to the military decision-making process<sup>14</sup>. Working from the assumption that “Likewise battle between two opposing military forces is a two-person game”<sup>15</sup> he analysed a valid “Estimate of the Situation” at that time by using the structure of a zero-sum game, and found that: “The identity of the doctrine of the “Estimate of the Situation” with the minorant game of the von Neumann theory is significant. The minorant game is the most conservative possible play of the game.”<sup>16</sup> In his view a decision rule, which is only oriented to the enemy’s capabilities and not to his intentions, does not carefully weigh the opportunities and risks. Therefore he insists: “Game theory may well serve in this role as a stimulus and tool for the development of doctrines of decision.”<sup>17</sup>

Four years later the same Haywood published an informative study about two major World War II operations, which he analyses with the instruments of game theory<sup>18</sup>. One of these is the Avranches-Gap Situation which occurred in 1944 as part of the landings in Normandy (D-Day) when the US troops under General Bradley and German forces under the command of Field Marshal von Kluge faced one another. The second subject of investigation happened in the Pacific War and is called the Rabaul-Lae Convoy Situation (also: Battle of the Bismarck Sea) in 1943; it deals with the employment of US air forces against the movement of Japanese fleet in that area.

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<sup>13</sup> The Nobel laureate Aumann states: “The 1950s were a period of excitement in game theory. ... The major applications at the beginning of the decade were to tactical military problems: defense from missiles, Colonel Blotto, fighter-fighter duels, etc. Later the emphasis shifted to deterrence and cold war strategy, with contributions by political scientists like Kahn, Kissinger, and Schelling.” See **Aumann, Robert J.** 1987. *Game theory*. – Eatwell, John; Milgate, Murray; Newman, Peter (eds). *The New Palgrave – A Dictionary of Economics*, Volume 2. London/New York/Tokyo, p. 467.

<sup>14</sup> See **Haywood, Oliver G.** 1950. *Military Decision and the Mathematical Theory of Games*. – *Air University Quarterly Review*, 1950 (1), pp. 17–30.

<sup>15</sup> *Ibid.*, p. 20.

<sup>16</sup> **Haywood** 1950, p. 28.

<sup>17</sup> *Ibid.*, p. 30.

<sup>18</sup> See **Haywood, Oliver G.** 1954. *Military Decision and Game theory*. – *Journal of the Operations Research Society of America*. 1954 (4), pp. 365–385.

In the US, theorists such as Herman Kahn also used game theoretic methods, and the Nobel laureate Harsanyi as well outlines: "In the period 1965–69, the U.S. Arms Control and Disarmament Agency employed a group of about ten young game theorists as consultants. It was as a member of this group that I developed the simpler approach, already mentioned, to the analysis of I-games. I realized that a major problem in arms control negotiations is the fact that each side is relatively *well informed* about *its own position* ... but may be *rather poorly informed* about the *other side's* position in terms of such variables."<sup>19</sup>

The economist, and 2005 Nobel laureate, Thomas Schelling has intensively researched scenarios of the Cold War, such as nuclear deterrence, and the arms race from the perspective of game theory. The core element of his theory is the conclusion that in most cases, conflict situations (to be understood as a two-person game) can be regarded as a mixture of pure confrontation on the one hand, and common interests on the other. It is because of this twin character that Schelling sees the difficulty of assigning this type of game to either the cooperative or to the non-cooperative game. He therefore created a new terminology, calling them mixed-motive games. According to Schelling, military-strategic considerations clearly belong to this class of games.

On the basis of this mixed motive model Schelling concentrates on "the exploitation of potential force", i.e. he does not place the focus on the real deployment of forces. On the contrary, he lays emphasis on the threat of force as a means of avoiding war, but without neglecting the enforcement of one's own interests. This pre-war orientation needs to be seen in the context of nuclear weapons, their strategic effect and potential for escalation, but regardless of this Schelling's argumentation is determined by his concern that under the umbrella of the Cold War each (regional) conflict, although it may be of a limited and conventional nature in the beginning, can develop into a larger armed conflict between the bloc powers. Conflicts are generally decision situations in which the options to act on one side will depend on the intentions of the other party (Schelling: "theory of interdependent decision"); this fact, in combination with the existence of partially parallel interests, provides the opportunity to coordinate actions in mutually beneficial synergy.

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<sup>19</sup> **Harsanyi, John C.** 1994. Games with Incomplete Information. Nobel Lecture, December 9, 1994, p. 138; complete text of the lecture under: <[http://nobelprize.org/nobel\\_prizes/economics/laureates/1994/harsanyi-lecture.pdf](http://nobelprize.org/nobel_prizes/economics/laureates/1994/harsanyi-lecture.pdf)>, (27.02.2009).

To achieve such a level of cooperation, Schelling proposes the method of bargaining, either in explicit or tacit form (“Trading with the enemy”<sup>20</sup>).

Altogether, this limited selection of examples of game theoretical thinking in military affairs can only indicate to what extent this area of science has meanwhile developed as an instrument of analysis of strategic problems and as a supporting tool for decision-making. Two fundamental directions can be differentiated: (1) Models of game theory are capable of providing, within the framework of a lessons learned-process, explanatory approaches to military operations already completed. (2) Game theoretical patterns of thoughts can be useful in the decision-making process, if the rules of the game can still be influenced; Schelling, makes this very clear with his considerations about commitment and threats in connection with the advantages and respective disadvantages of a first or second move<sup>21</sup>.

Clausewitz has dealt in many ways with the subject of strategy. Worth particular mention, are the document “Strategie” of 1804 (with amendments of 1808 and 1809<sup>22</sup>), the paper “Die wichtigsten Grundsätze des Kriegführens zur Ergänzung meines Unterrichts bei Sr. Königlichen Hoheit dem Kronprinzen”<sup>23</sup>, and, of course, his masterpiece “On War”<sup>24</sup> which he himself understands to be a book about strategy (“The theory of major operations (strategy, as it is called) ...” [70]).

The starting point of his edifice of ideas is the basic premise that “According to our classification, then, tactics *teaches the use of armed forces in the engagement*; strategy, *the use of engagements for the object of the war.*” [128] When Clausewitz uses the term “teaches” in connection with strategy, this does not mean at all that he is presenting a set of regulations (“A positive doctrine is unattainable” [140]; he rather intends to give us guidance for thinking: “Theory should be study, not doctrine” [141]. Therefore, his understanding of a theory reads as follows: “It is an analytical investigation leading to a close *acquaintance* with the subject; applied to experience – in our case,

<sup>20</sup> See **Schelling, Thomas** 1975. A Framework for the Evaluation of Arms-Control Proposals. – Dædalus. 1975 (3), p. 189; **Schelling, Thomas** 1984. Choice and Consequence. Cambridge (Mass.)/London, p. 249.

<sup>21</sup> See **Schelling, Thomas** 1960. The Strategy of Conflict. Cambridge (Mass.), p. 124.

<sup>22</sup> This document was first published about 100 years later: see **Kessel, Eberhard (Hrsg.)** 1937. Carl von Clausewitz – Strategie aus dem Jahr 1804 mit Zusätzen von 1808 und 1809. Hamburg.

<sup>23</sup> **Clausewitz, Carl von** 1980. Vom Kriege. Troisdorf, S. 1047 *et seq.*

<sup>24</sup> The now following quotations from this book do all refer with its {page numbers} to the translated edition by Howard, Michael and Paret, Peter from 1989.



to military history – it leads to thorough *familiarity* with it.” [141] In view of the above, in the following it shall be examined whether game theory can be suitably integrated into Clausewitz's set of instruments for analysis.

The basic structure of Game theory as a method of decision-making in interactive situations is found relatively easily in Clausewitz's universe of ideas. Under the headline “War is an Act of Human Intercourse” (Book Two, Chapter Three) Clausewitz states that war “is part of man's social existence”, and describes it as “a clash between major interests.” [149] In view of his multiple remarks about the interdependence of the opponents (see e.g. [80] [136] [586]) it becomes quite clear that for Clausewitz all military operations have a social dimension and an interactive character. In that regard one can find a remarkable congruency between the basic model of game theory and Clausewitz's understanding of the nature of war and its inherent military-strategic thinking.

Another relevant element of game theoretic reasoning is information and its availability for all parties concerned. For Clausewitz this factor is also of importance (although he does not use the word “information” but rather makes use of other terms with the same sense, which were common to the language of his time). In a letter to Major Röder in 1827 he wrote that strategic design must, by necessity, be created due to the war efforts of both parties, while also adding some considerations about the necessary situational information<sup>25</sup>. In “On War” some parts of the text underpin this requirement, inter alia the following statement: “... , we must first examine our own political aim and that of the enemy. We must gauge the strength and situation of the opposing state. We must gauge the character and abilities of its government and people and do the same in regard to our own. Finally, we must evaluate the political sympathies of other states and the effect the war may have on them.” [586] From this it can be deduced that Clausewitz's military-strategic considerations are based – similarly to the approach of game theory – on a look at the situation from two perspectives, namely from one's own and from the hostile one, and in a weighing of the mutually existing action potentials, take into account their interrelationships.<sup>26</sup>

<sup>25</sup> See **Rothfels, Hans** 1923. Zwei strategische Briefe von Clausewitz. – Wissen und Wehr, 1923 (3), S. 166.

<sup>26</sup> Under the headline “On the Theory of War” (Book Two, Chapter Two) Clausewitz rejects the dominant practice of his time, to look only at the own capabilities and skills. This perception finds its expression by saying e.g. “They consider only unilateral action, whereas war consists of a continuous interaction of opposites.” [136]

Very often Clausewitz uses the term “probability”, and does so in a two-fold sense: on the one hand he is focused on the likelihood of success, and he points out some factors which may have a positive impact on this aim (“In war, of course, one is always looking to have a chance of succeeding, either by physical or moral advantages.”<sup>27</sup>); on the other hand, he combines this with some assessments of the enemy (“From the enemy’s character, from his institutions, the state of his affairs and his general situation, each side, using the laws of probability, forms an estimate of its opponent’s likely course and acts accordingly.” [80]) The first of these two aspects rather illuminates the later act of executing a strategic decision, following his maxim “to make the best use of the available resources”<sup>28</sup>. The second aspect, however, is clearly of game theoretic character, because it is used by Clausewitz to describe the development of a military strategy as a process of mutual conjectures with feedback effects. And this is precisely the basic model of game theory.

In its origin game theory is based on a fictitious character *homo oeconomicus* (a fictional being situated in the economic sciences), i.e. and assumes that all stakeholders involved act completely rationally, and are focused on the maximisation of their benefit. Based on that are inter alia the principles of the dominant strategies, the Nash equilibrium, and the Subgame perfect equilibrium. Clausewitz himself implies that the commander-in-chief will also follow a rational principle, and consequently one will find in his work some references to economic principles. In a fundamental way he points out: “In the utilization of a theatre of war, as in everything else, strategy calls for economy of strength. The less one can manage with, the better; but manage one must, and here, as in commerce, there is more to it than mere stinginess.” [500] Admiring the King’s strategy in the Seven Years’ War he praises Frederick the Great of Prussia “But for seven years he skilfully husbanded his strength ...” [94]. The comparison of war with trade [149] is also an indication of his cost-benefit thinking, as are his considerations about the expenditure of force in relation to the purpose envisaged [81] [92] [322]. With the statement “Each unnecessary time exposure, each unnecessary detour is a waste of strength and therefore an abomination for strategic plans”<sup>29</sup> it

<sup>27</sup> See **Clausewitz** 1980, p. 1048 (translation of this quotation by the author).

<sup>28</sup> See **Clausewitz, Carl von** 1805/1956. *Bemerkungen über die reine und angewandte Strategie des Herrn von Bülow*. Neue Bellona, Neunter Band, S. 252–287. – Nachdruck in *Wehrwissenschaftliche Rundschau*. Nohn, Ernst A. 1956. *Der zeitgemäße Clausewitz*. Beiheft 5, S. 12.

<sup>29</sup> See **Clausewitz** 1980, p. 1020 (translation of this quotation by the author).

becomes obvious that the gap between revenue and use of resources should be as large as possible. Thus the fundamental premise of game theory is echoed in Clausewitz's understanding of the strategic outturn account.

Three fundamental directions of methodological approach can be found in his main opus "On War": (1) primarily a philosophically-dialectically oriented thinking and reasoning; (2) furthermore a rationale, which is based on comprehensive studies of historical battles and wars; (3) finally, a critical assessment of the strategic theories of his time, as well as an analysis and evaluation of real conflicts of that time (campaigns of Napoleon, Wars of Liberation). The philosophical orientation in his work – influenced by the teachings of Kant and Kieseewetter – is manifested by his effort to recognise the phenomenon of war in its real substance, inner logic, and timeless character<sup>30</sup>; his dialectical approach aims to examine each subject-matter via its antipoles. The main purpose for Clausewitz is to bring theory and practice into harmony. His appreciation of military-historical events is expressed in his formulation of the power of historical evidence and is reflected in numerous studies of battles and campaigns (the fourth to the tenth volume of his *Hinterlassene Werke* is a testament to this). In view of the Napoleonic wars of conquest and the resulting tendencies in the manifestation of armed conflicts he says: "Since Bonaparte, then, war, first among the French and subsequently among their enemies, again became the concern of the people as a whole, took an entirely different character, or rather approached its true character, its absolute perfection. There seemed no end to the resources mobilized; all limits disappeared in the vigour and enthusiasm shown by governments and their subjects. Various factors powerfully increased that vigour: the vastness of available resources, the ample field of opportunity, and the depth of feeling generally aroused. The sole aim of war was to overthrow the opponent. Not until he was prostrate was it considered possible to pause and try to reconcile the opposing interests." [592] He combined these thoughts with a massive critique of the military literature which then prevailed.

Clausewitz expresses more than once his poor opinion of the theories of war of his time. The study "Bemerkungen über die reine und angewandte Strategie des Herrn von Bülow"<sup>31</sup> as well as "Ueber den Zustand der Theorie

<sup>30</sup> "We should like to add that this chapter, more than any other of our work, shows that our aim is not to provide new principles and methods of conducting war; rather, we are concerned with examining the essential tenets of what has long existed, and to trace it back to its basic elements." [389]

<sup>31</sup> Clausewitz 1805/1956.

der Kriegskunst”<sup>32</sup> bear witness to this attitude. Also in “On War”, of course, Clausewitz addresses this aspect, e.g. in the section “On the Theory of War” (Book Two, Chapter Two). Thus from these multiple sources it can be deduced that his general creed is to not force strategy into the straitjacket of a positive doctrine with fixed rules. It becomes rather clear that his basic idea is to impart a profound basis of insight, as well as suitable foundations for assessment, and a basis for making decisions. Accordingly, his main effort is concentrated on the training of the mind (“In our reflections on the theory of the conduct of war, we said that it ought to train a commander’s mind, or rather, guide his education; theory is not meant to provide him with positive doctrines and systems to be used as intellectual tools.” [168]). The instrument for this training is what he calls “critical research”, i.e. a deep analysis of the subject, the result of which must then be juxtaposed with the theory.

Clausewitz states that “so-called mathematical factors never find a firm basis in military calculations” [86], and he completely disagrees with the attempts to reduce the conduct of war down to measurable dimensions and geometric forms<sup>33</sup>. This attitude does not seem to harmonize with mathematically oriented decision-making techniques. However, one must understand this massive rejection as a renewed denial of any attempt to construct a model, with normed instructions, to manage real war situations/strategic decisions. Another nuance of his thinking becomes obvious when he answers to the question “Should a commander-in-chief know much about mathematics?” with the statement “if he has studied it for to train his mind, then it might be good for him, ...”<sup>34</sup>; so, as a training of the intellect, Clausewitz considers mathematics to be a pursuit which makes very good sense. Let us now combine this last statement with the aforementioned tool of critical research as a method of analysing the subject. If historical examples are this subject, then game theory can be considered as an analytical tool in the sense that Clausewitz intended, in that it is appropriate for an *ex post* oriented evaluation. It is in this capacity that it can help the process of “analytical investigation leading to a close *acquaintance* with the subject applied to experience – in our case military history – it leads to thorough *familiarity* with it. The closer it comes to this goal, the more it proceeds from the objective form of a science

<sup>32</sup> This essay is a preliminary work to “On War”; see **Clausewitz, Carl von** 1990. *Schriften – Aufsätze – Studien – Briefe. Zweiter Band* (1. Teilband). Hrsg. von Werner Hahlweg. Göttingen, p. 23 *et seq.*

<sup>33</sup> Cf. the section “On the Theory of War” (Book Two, Chapter Two).

<sup>34</sup> **Clausewitz, Carl von** 1937. *Strategie*. Hrsg. von Eberhard Kessel. Hamburg, S. 39.

to the subjective form of a skill, ..." [141]. The character of game theory gains even greater importance, for as Clausewitz states: "Military activity is never directed against material force alone; it is always aimed simultaneously at the moral forces which give it life, ..." [137]; i.e. it is not enough to only assess the material capabilities of the enemy, but also to take into consideration his intentions.

Finally, another reference to a passage in "On War" shall demonstrate, how much Clausewitz's understanding of causes, effects, links and their assessments resembles the thinking of game theory. In the section about "Critical Analysis" (Book Two, Chapter Five) he points out that war is a coherent whole, in which each subtransaction has an influence on the final result. For him the cause-and-effect relationship, to be considered over several steps ("One can go on tracing the effects that a cause produces so long as it seems worth while." [158]) is an important assessment criterion. In the same manner he sees the importance of means and ends, and he underlines especially that a means on one level becomes an end at the next higher level, possibly with a different value ("Every stage in this progression obviously implies a new basis for judgment. That which seems correct when looked at from one level may, when viewed from a higher one, appear objectionable." [159]). For both, the cause-and-effect relationship and the link between means and ends, Clausewitz demands "The pursuit of this chain, upward and downward, ..." [159] in order to clearly identify the interrelation with the desired end-state as well as to measure the contribution of a single action in view of the big picture.

Following these reflections about the cause-and-effect relationship and the link between means and ends, Clausewitz analyses Napoleon's campaign in Italy in 1797<sup>35</sup>, thus concretising a theoretical discussion with a real-life example. First, he analyses the decision-making situation at the level of Napoleon, then considers the 'higher' viewpoint of the French Directory, and in a further step he turns to the Austrian side with Archduke Charles and considers the existing options for action and intentions. As a consequence of these considerations he assesses all courses of action, coming to the conclusion that Napoleon did well when he agreed "to sign the peace of Campo Formio, on conditions that imposed on the Austrians no greater sacrifices ..." [160].

The entire passage, in fact, makes use of the game theoretic model game tree. And when he says "In a critical analysis of the action, the search for the

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<sup>35</sup> See *ibid.*, S. 159 *et seq.*

causes of phenomena and then testing of means in relation to ends always go hand in hand, for only the search for a cause will reveal the questions that need to be studied.” [159] this is clearly the method of backward reasoning Subgame perfect equilibrium! Finally, at the end of this passage he additionally states “Critical analysis is not just an evaluation of the means actually employed, but of all *possible means* – which first have to be formulated, that is, invented” [161], and this statement precisely applies to the definition of “strategy” in the sense of game theory.

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As a conclusion it can be said that it is not only a theoretical construct, to link elements of game theory with Clausewitz’s strategic thinking; on the contrary, his philosophical considerations of war in all its facets find its equivalent in the basic models of game theory. So, in response to the initial question, it can be assumed, that Clausewitz, if he had had knowledge of this area of science, would have been open to game theoretical methods. Of course, he would always have insisted on not deducing doctrinal formulas and rules from the models, but he would have accepted game theory as a tool to train the mind and to improve the intuitive judgment. He views such permanent training as essential, and therefore states: “No activity of the human mind is possible without a certain stock of ideas; for the most part these are not innate but acquired, and constitute a man’s knowledge.” [145]

In his work, these are Clausewitz’s fundamental concerns: to offer an approach to the complexity of the phenomena of war; to identify the acting factors therein; to record the interdependent relationship between cause and effect; it is these facets that must be combined and focused to create a basis for the formation of an independent opinion (“Knowledge must become Capability”; Book Two, Chapter 2). In the pursuit of this goal Clausewitz uses the scientific findings of his time. For obvious reasons he did not have access to the results of contemporary research such as sociology, psychology, political science, nor game theory. However, it has been shown that game theoretic models are not only formally included in Clausewitz’s understanding of strategy, and that game theory is also a useful part of a well-rounded education. If Clausewitz and his works are still to be considered relevant (and his main book is not to be used as only a popular quarry for quotations!), then an officer’s training and education should also take into account Game theory as an important tool of thinking.

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