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The main objective of the present study of experimental economics is to examine and describe individuals’ decision making in different hypothetical medical distributive problems. Participants had to allocate amounts of the medical resource treatment time to hypothetical patients that were described by certain characteristics related to their needs and potential benefits from treatment. Based on results of a former study of Ahlert, Funke & Schwettmann (2012) we classified allocation behaviour with respect to the mental model of Gueth (2000, 2001) in bounded rational decision making. Decisions in a sequence of two situations with different degrees of availability of the medical resource but identical properties of patients to be treated are compared. Three different types of decision makers can be distinguished. Firstly, an allocation type who applies a once chosen distributive principle in every decision situation. Secondly, there are egalitarian distributors who act patient-related across the two situations. However, these distributors differ with respect to the kind of equality criterion applied, equality of amounts of the resource or equality of gains in health benefits for the patients. Thirdly, there are individuals who have one basic concept of distribution in mind but decide dependent on the availability of resource and benefits for the patients. There is evidence that the degree of availability of the resource predominantly influences decision behaviour of medical but not of economic students.

Keywords: medical decision making; decision experiments; cognitive processes; mental models; distributive justice

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1. Introduction

The German public health sector is faced with a discrepancy between an increasing demand for medical services and a limited amount of resources or financial funds to fulfil that demand (Gandjour & Lauterbach, 1999; Oberender & Zerth, 2006; Oduncu, 2012; Porter & Guth, 2012). In this regard a prioritisation in allocating health care seems to be inevitable. For those who are involved in these decisions they often are perceived as hard choices (cf. Strech, Börchers, Freyer, Neumann, Wasem & Marckmann, 2008).

The goal of this paper is to shed some light on the decision making processes when scarce medical resources have to be allocated to patients. We modelled several distributive situations with different available amounts of resources, primarily treatment time. Furthermore, hypothetical patients are characterised by some properties that describe their gained health benefits from allocated amounts of the resource. The choices of participants in our experiments are classified by theoretically and empirically founded allocation principles. Our aim is to gain insight into the underlying cognition of individuals’ decision making. Moreover, we aspire to classify the applied distributive principles in a cognitive framework. Subsequently, we try to imbed our results into the findings of economic and cognitive research.

In our study decision making of individuals is considered from the perspectives of two fields of research, on the one hand from the economic and on the other hand from the cognitive one. One of our objectives is to interconnect both disciplines when analysing our medical decision making experiments. Let us first turn to the concept of bounded rationality as an economic principle of decision making. Primarily noted by Simon (1955, 1959), it assumes individuals’ decision behaviour to be a function of costs and benefits of their decision making. The decision making process is limited by bounded cognitive capabilities. As also discussed by Jones (1999) bounded rational decision makers are intended rational, they are goal-orientated and adaptive but sometimes fail because of their human cognitive and emotional architecture. In this regard most studies on bounded rationality negate the postulate of rationality modelled in the neoclassical theory of homo oeconomicus by involving limited cognitive abilities in decision making processes (cf. Gigerenzer, 2001). Moreover, Gigerenzer (2001) and Marewski, Gaissmaier and Gigerenzer (2010) state that boundedly rational decisions do not need complete information but rather rely on smart heuristics which are fast and frugal. These domain-specific and learned or inherited heuristics are summarised in an “Adaptive Toolbox” (cf. Gigerenzer, 2001). The heuristics conduce to find a good solution for the achievement of a given aim. For example, recognition is a frugal heuristic. It is particularly useful when ranking many alternatives. Furthermore, it initialised a fast and frugal heuristic in form of Take-the-Best, which compares two alternatives with regard to the highest score on a criterion. Similarly, Hauser and Wernerfelt (1990) describe decision making as an evaluation process of multiple alternatives. First, a smaller set of relevant alternatives is formed. After a more detailed examination of the alternatives in this con-
sideration set, a choice is made. In other words, a decision maker applies a strategy that best matches her situational assessment and motivation (Jungermann, 2004).

In terms of cognitive psychology people are described as information processing and learning organisms (Hanstein, 1993). Internal mental processes, environmental events and the resulting behaviour of an individual are interpreted in a system which leads to a consistent language of information structure and processing. Comparable assumptions were already made by Bandura (1978) who models behaviour as a dyadic person-environment-interaction as well as a triadic reciprocal function of an interaction of person, environment and behaviour. In contrast, Kahneman and Tversky (1984) discuss the development of decision processes in a more prognostic way. The authors postulate that people form psychological accounts containing the advantages and disadvantages of an option in relation to a relative multi-attribute reference state. This concept is called mental accounting and can be seen as a type of decision framing. Further on, Henderson and Peterson (1992) explore the underlying processes of mental accounting. They argue that mental accounts are nothing more than a type of category including the advantages and disadvantages of the element being categorised by using certain categorisation principles.

A first comprehensive approach that connects economic results of bounded rationality with cognitive aspects of possible underlying decision making processes was made by Gueth (2000, 2001). These two studies constitute the basis for the cognitive model in the present paper. Gueth there develops assumptions and properties of cognitive decision making processes and conceptualises them verbally and graphically in a mental model. He analyses the decision making process in different experiments, where a proposer has to decide on the division of money between herself and other subjects. Among other situations he focuses on dictator giving in experiments. The results also contribute to theories of bounded rational decision making in interactive structures of games (cf. Gueth, 2000, 2001; Gueth & Kliemt, 2010). In Gueth’s concept it is assumed that the world of every human actor can be represented by some mental model. Moreover, a mental model is affected by evolution and consists of experiences, good or bad decision rules as well as qualitative and quantitative decision rules related to specific types of decision problems. Such rules are also described in an “IF such and such, THEN so-and-so”-form. This reflects the valuation of possible consequences of an action (Gueth, 2008). Learned behaviour in social situations has an influence on choice making. In a more complex theory human choice making is based on dynamic thinking processes. Its stages include either an activation of “an intention generator and its corresponding intention filter or,…, an ex post-evaluation of the actual behaviour.” (Gueth, 1995, p. 329). The intention generator analyses the decision problem whereas the intention filter tests if the intended behaviour is suitable for the problem.

Ahlert, Funke and Schwettmann (2012; AFS, 2012 from now on) in classroom experiments have investigated distributive behaviour in situations that are a type of dictator games, consisting of a distributive task without strategic interaction. However, our games had a more complex framing than simple dictator games. Subjects – students from economics, medicine and law – had the role of a distributor. They had to decide on
the distribution of a given amount of a resource either in a medical or in a neutral context. The participants achieved questionnaires that consisted of a sequence of four decision problems. There were situations with two and with three recipients who were characterized both by different required minimum amounts of the resource and by varying productivity factors as indicators for individual benefit. In some distributive problems the amount of the resource suffices to achieve the minimal needs (sufficiency situations), in others there was not enough resource to cover the minimal needs (non-sufficiency situations). So, in non-sufficiency situations it was inevitable to decide which recipient would get nothing of the resource. The decision was incentivised (cf. e.g. Davis and Holt, 1993, cited by AFS, 2012, p. 5). Monetary payoffs of recipients and of the distributor depended on the chosen allocation. The monetary payoff of each recipient was proportional to her allocated amount multiplied by the productivity factor. The payoff of the distributor was proportional to the sum of all payoffs of all recipients.

Altogether, AFS (2012) identify and discuss several allocation principles subjects used by distributing the limited resource. The principles are based on theoretically founded distributive rules from social choice theory and have also been applied in a distributive experiment by Ahlert, Felder and Vogt (2012). A comparable study which also deals with allocation principles in medical distributive problems was published by Persad, Wertheimer and Emanuel (2009). Their findings reveal eight simple principles that are classified into four categories and combined into multiprinciple allocation systems.

Amongst others, in AFS (2012) two important impacts on the distributive principles applied by distributors are discussed. Firstly, the field of study matters. Secondly, the order in which situations with different degrees of availability of the resource (sufficiency situations vs. non-sufficiency situations) are presented in the questionnaire has some influence. The second finding lays the ground for the present study.

The important common feature of the studies analysed in Gueth (2000, 2001), and in AFS (2012) is that a decision maker has to decide on the distribution of a given amount of a resource to subjects and thereby implies monetary consequences of the chosen distributions to herself and to the others. The main objective of our study is to apply the cognitive psychological concept for modelling the decision process proposed by Gueth (2000, 2001) to several medical decision problems in AFS (2012). Thereby, the focus of the study is to conduct analyses that consider every single individual. Furthermore, we present a model that reflects the possible underlying cognitive activities when distributing sufficient and non-sufficient amounts of a medical resource to hypothetical medical patients.

On our way to construct a mental model for the distributive choices in our experimental design the following questions should be answered by simple descriptive statistics:

(Q I): What kind of distributive principles are revealed by participants of different fields of study across situations of varying degrees of availability of resource?

(Q II): Which impact has the order of presentation of the sufficiency and non-sufficiency situations on the distributive decisions of the participants?
In a second step we implement our findings into a cognitive model which demonstrates the cognitive generation of possible choices. The following research question will be answered:

(Q III): What kind of modular mental model for making a distributive decision can be derived from the observations and how can the choices of bounded rational decision makers be classified according to the modules of that model?

The paper is organised as follows. In Section 2, data set and methods of the experiment are presented and discussed. The obtained results are exemplified and discussed in Section 3 by dividing them into quantitative and qualitative results. Section 4 describes a mental model for the most prominent allocation principles and the associated modules. In Section 5 some limitations of our experimental design are discussed. A summary of the main findings is offered in the final Section 6.

2. Data Set and Methods

2.1 Subjects

The total sample we included in our examinations consists of \( N = 109 \) participants who received a questionnaire with the medical context. All participants are students of different fields of study, predominantly from the Martin-Luther University Halle-Wittenberg. Due to missing answers \( n = 7 \) respondents were excluded from further examinations. The resulting sample consists of \( N = 102 \) respondents. In that sample \( n = 55 \) (53.92\%) subjects received the sufficiency situation first and \( n = 47 \) (46.08\%) subjects the non-sufficiency situation. 32.35\% are students of economics and 67.65\% are students of medicine. The mean age of the included participants is \( M = 23.42 \) (\( s = 2.13 \)) years. 33.30\% of all students are male and 66.70\% female. Dependent on the sequence from sufficiency to non-sufficiency or vice versa two corresponding sub-samples among students of economics and medicine can be differentiated.

2.2 Material

In the present study we concentrate on a subset of the questionnaire data from AFS (2012) containing a comparison of a medical and a neutral context. Here, we solely deal with one of the two contexts - the medical one. So, in the following we will name recipients as patients (or persons) and distributors as physicians. We focus on the effects of differently ordered availability of the medical resources in the questionnaires and therefore only analyse the responding situations. In these situations always an identical set of three hypothetical patients have to be treated. Within but not between both situations patients differ with respect to minimally needed amounts of treatment time as well as productivity factors. Moreover, the minimum amounts act as threshold values which are necessary to benefit from treatment at all. The individual productivity factors are part of
A monetary payoff function that reflects patients’ benefits. All participants from economics and medicine have answered the questionnaire versions we are interested in and thus are included in our examination.

In the considered questionnaires there are two special modifications we want to compare. In the first modification the first three person problem is embedded in a sufficiency situation being followed by a non-sufficiency situation. The second modification consists of a firstly presented non-sufficiency situation being followed by a sufficiency situation. To analyse the order effects of varying degrees of scarcity of the medical resource we compare both modifications. By presenting a situation where not all patients can be treated, we induce a participants’ dilemma. It reflects the necessity to exclude at least one recipient from receiving the medical treatment. Each of the considered subjects received only one of the two modifications. An example for the sequence sufficiency – non-sufficiency is given in Table A.1 of Appendix A. Detailed information about recruiting of participants, questionnaire design, and methods of data acquisition as well as the conditions of the survey is given in AFS (2012).

In AFS (2012) the main part of the statistical analysis was conducted over all participants within a field of study for one situation. In this study, in contrast, we focus on single participants from a certain field of study over all situations. We apply descriptive quantitative methods to answer the questions Q I and Q II. Furthermore, the mental model for decision making is designed to answer question Q III in a more qualitative way.

2.2.1 Quantitative Methods

In order to analyse the allocation principles made in both examined situations of a questionnaire version we computed crosstabs for all individuals separately for each field of study. Afterwards, we descriptively examined the distributive principles for the two modifications of sufficiency and non-sufficiency within every sub-sample. The determined frequencies were the basis for the following qualitative analysis.

2.2.2 Qualitative Methods

Under the assumption that decisions are a result of a dynamic cognitive process the underlying process can be described in terms of a modular system (see Hanstein, 1993). Moreover, it can be illustrated as a flow chart. Because of its character to connect two fields of research, we decided to develop a mental model based on Gueth’s in 2000 published model. In doing so, we use and specify the assumptions of his model. Like the author, we compose the system out of four basic modules; however, we add an information processing module for the instructions. The main module of the mental model is the so called “Master Module” (MM). The MM includes a behaviour repertoire with good or bad as well as qualitative or quantitative decision rules for different kinds of decision problems. It reflects the mental process of analysing the existence of a former qualitative similar situation in which a decision was made. The individual’s experiences with decision rules in a comparable situation in the past are integrated into the model of
the cognitive process governing the next decision. Moreover, we develop and implement a further new module that reflects the perception of information given in the instruction. Depending on qualitative or quantitative similarity of the present situation compared to a past situation one of three possible modules has to be applied – “New Problem Solver” (NPS), “Adaptation Procedure” (AP) or “Learning Module” (LM). The “New Problem Solver” is chosen in situations where there exists neither qualitative nor quantitative similarity to an existing decision problem. If there is qualitative and quantitative similarity between both situations the “Learning Module” is entered. Furthermore, the “Adaptation Procedure” is applied if two compared situations are only qualitative similar. A more detailed discussion of all basic modules can be found by Gueth (2000, 2001).

2.3 Procedure

The study was conducted in several institutions of the Martin-Luther University Halle-Wittenberg as well as at the university hospital in Jena. Within the years 2008 to 2009 we accomplished three separate data acquisitions that build up the total sample of AFS (2012). A detailed description of the procedure is also given in that study.

3. Results

3.1 Descriptive Analyses

In a first step we performed simple descriptive analyses in the form of absolute and relative frequencies to have a starting point for constructing the cognitive model of decision making.

In the following we discuss some of the most prominent distributive principles we observed in AFS (2012) and also in our quantitative analyses. These principles can be distinguished by the distributors’ view of the distributive problem. Either she focuses mainly on the amounts that are allocated including patients’ minimum needs or rather the consequences for the patients or herself, considering more characteristics, e.g. also patients’ productivity and patients’ payoffs. In the following we describe the most prominent distributional types for sufficiency situations and for non-sufficiency situations.

First, consider the allocation type TU (Truncated Utilitarian). This type of distribution follows the goal to maximise the sum of the recipients’ payoffs under the restriction of first completely allocating all minimal amounts. Under this goal in a second step the remaining amount of resource will be given the most productive person. An analogous principle for non-sufficiency situations is the distributional type TU_P. Firstly, under TU_P the person with the lowest productivity is excluded and afterwards the principle allocates in the same way like TU (in our problems exclusion of one patient always leads to a new problem where the total amount suffices to cover the minimal amounts of the remaining two persons). The more egalitarian type LP (Leximin in Payoffs) allocates the minimal amounts and then compensates for low productivity. This type tries to find an
allocation such that the resulting payoffs for patients are equal (if possible) and as large as possible. Sometimes equality in payoffs cannot efficiently be achieved. In this case type LP applies the lexicographic maximin criterion to the payoffs of the patients. TS (Truncated Split), also an egalitarian type, distributes the minimal amounts to all patients first and then splits the (possibly) remaining quantity equally. In contrast, the Payoff Maximiser (PM) maximises her payoff as the distributor by allocating the total amount of the resource to the most productive one of the patients. The classical utilitarian allocator (U) is looking for maximising the ‘utility sum of all patients’. In our questionnaire design the ‘utility of a person’ is defined as being the payoff of that individual and the sum of these payoffs constitutes the payoff of the distributor. Because PM and U lead to identical allocations as well as an exclusive focus on productivity we will consider them on one level. There are also a few allocation types that are chosen less often. Those are not further investigated in our analyses.

Table B.1 in Appendix B lists the examined sequences of allocation decisions of the participants of every sub-sample depending on order of sufficiency or non-sufficiency situations for the medical context. Three sequences are standing out. Altogether, these most frequently chosen sequences of both resource variations are TU x TU, (TU x LP) with n = 19 followed by TS x LP (LP x TS) with n = 17 and TU x LP (LP x TU) with n = 13.

In the sequence of a sufficient amount followed by a non-sufficient amount TU x TU, is similarly preferred by economic students and medical students. In choosing the same truncated type of utilitarian allocation in the first presented sufficiency situation and in the non-sufficiency situation afterwards these subjects maintain their principle and are consistent in this regard. The same phenomenon of consistency can be observed when people use such a distributive scheme in case of a firstly presented non-sufficiency followed by a sufficiency situation (TU x TU). In all of these cases it seems to be not important for the decision making of those students at which position the non-sufficiency problem is presented in the questionnaire, since they always apply the same principle.

Regarding TU x LP (LP x TU) about 15% of the economists chose LP in a non-sufficiency situation and TU in a sufficiency situation independent of the order of the situations. In contrast, for the medical students the position of the non-sufficiency situation in the questionnaire seems to be relevant. About 20% of them preferred LP x TU in the questionnaires where the non-sufficiency situation was given first, and only round 6% chose TU x LP in questionnaires where the non-sufficiency situation was presented at the end. However, more than a quarter of students of medicine chose the sequence LP x TS in situations where the non-sufficiency situation was given first. About 17% of the medical students preferred the respectively inverse sequence TS x LP of allocation principles in the questionnaires where the non-sufficiency situation was presented last. U, PM x U, PM is a distributive choice which is only observed among economic students in a firstly given non-sufficiency situation.
Moreover, Table B.1 in Appendix B shows a contrasting result between students of economics and students of medicine. A few of the economic students preferred the sequence \( TU_p \times 900-100-0 \) when the non-sufficiency situation was given first whereas some prospective physicians chose this allocation principle in the questionnaires where the non-sufficiency situation was presented afterwards (\( 900-100-0 \times TU_p \)). Almost 10% of participants of both fields of studies together revealed a distributive sequence in the form of TS \( \times TU_p \) or \( TU_p \times TS \), respectively. This allocation reflects that a non-sufficiency problem activates thinking towards efficiency. Beyond that, after firstly having chosen a more egalitarian (TS, LP) or utilitarian (TU) allocation, in a non-sufficiency situation only a minority of 5% economic and around 9% medical students chose a distributive principle in treating the “sickest” patients represented by the lowest productivity and in our case by the smallest minimal amounts (\( TE_M \)) first. This result is comparable with the category “Favouring the worst-off; prioritarianism” with the corresponding allocation principle “Sickest first” of Persad et al. (2009). In this regard, the authors assume that the fact of a non-sufficing resource is an important precondition for that kind of allocation type.

Only a few participants chose other sequences of distributive principles. Here, differences between the field of study and the position of sufficiency and non-sufficiency situations appear to be decisive. In some of those cases some patient receives a small amount of the resource but less than the minimum amount. In distributing less than the minimum amount the resulting benefit for such a patient is zero, whereas another patient could benefit from this wasted amount. This implies a waste of resources and corresponds to an inefficient allocation (e.g. Equal Split in a non-sufficiency situation). We interpret that kind of decision making as non-compliance in relation to our required rules given in the instruction. Due to this result we may assume that there are several persons with high motives of justice that defy given allocation rules. It may also be possible that those respondents did not understand the task.

To provide statistical evidence of the results we additionally performed \( \chi^2 \) tests in order to test whether the distributions of answers differ significantly in both samples with different order of sufficient resource. The results suggest an only marginal significant relationship between the chosen allocation types in a firstly given sufficiency situation compared to that obtained in a sufficiency situation followed on a non-sufficiency problem (\( \chi^2 = 105.07, df = 72, p = 0.007; \alpha = 0.05 \)).

3.2 Qualitative Analyses - The Top-Down Approach

Due to the results of AFS (2012) where allocation decisions are classified by distributional types we developed a system of categories that constitute a top-down approach of medical decision making. Three distinctive levels of cognitive decision making can be assumed (see Fig. C.1, Appendix C). These levels are explained by three main categories including at least two sub-categories in each case. The main categories are denoted by “Cognition”, “Criteria of Decision” and “Focus of Decision”. Altogether, Level 1, Level 2 and Level 3 constitute the Mental Level. At the end of the decision making processes made at that level individuals’ decision results in decision behaviour. This is implied by
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the chosen distributive principles including the underlying cognition parameters as well as criteria and foci of decision making. The whole system of individuals’ decision making is graphically described in form of a mental network.

In a first cognitive step Main Category I is entered on Level 1. This category, named “Cognition” includes three sub-categories which consist of the previous knowledge of the individual, the subjective importance of the stimulus information as well as the individual cognitive capabilities. We assume that all sub-categories may differ between the subjects. Thus, we consider each decision making process as being individually affected by varying degrees of the three sub-categories.

In the second step of our top-down decision making model two criteria of choice making are regarded (Main Category II). These criteria are classified into two types, the criterion of egalitarian and the criterion of (truncated) utilitarian decision making. Moreover, we assume that people who decide egalitarian, aim at allocations that are either egalitarian in resources or in consequences. In contrast, (truncated) utilitarian thinking people regard the consequences of their decision and look for the most productive allocation, which maximises the sum of all patients’ utilities, i.e. payoffs. The truncated form of utilitarianism offers a distributive scheme which provides a minimum of the resource to every patient, irrespective of aggregative utility considerations, and is utilitarian afterwards. However, egalitarian and utilitarian distribution principles differ in distributing the remaining quantity of the resource above the minimum requirements. A truncated utilitarian applies the utilitarian principle while an egalitarian distributor chooses an egalitarian solution by allocating the remaining resource as equal as possible or looking for an allocation with utilities as equal as possible. The distinction of the two criteria in turn leads to different foci which are reflected by the third Level “Focus of Decision”.

According to the applied criteria the focus can be either exclusive on amounts of resources or on consequences implied by allocated resources and productivity of the patients. In our design a focus on minimum amounts and productivities is reflected by the amount of resource spent on every patient as well as the resulting payoffs for the patients and the physician. However, in only regarding patients’ productivity and not minimal amounts, the aim of achieving a high own payoff by maximising patients’ aggregate benefits seems to be in the foreground. In contrast, those who only take the amounts of resources into account, not minimal amounts and not payoffs, may aspire to an equal allocation.

Altogether, due to the unconscious and not quantitatively measurable processes of decision making we have no evidence for the order of the applied levels of the top-down approach. This basically concerns the criteria as well as the focus of decision.

In the next step we classify the examined most prominent principles (see Table B.1 in Appendix B) with regard to the top-down approach of medical decision making. Table D.1 of Appendix D demonstrates the chosen principles per sequence. Furthermore, criteria and focus of participants’ decision making are illustrated.

In the two compared sequences ($q = 1,000$ to $q = 600$ vs. $q = 600$ to $q = 1,000$) three prominent types of sequences can be distinguished. These types describe the chosen
allocation principles in that way that a first chosen allocation criterion is retained or changed in the two compared allocation tasks within a questionnaire. Regarding the allocation principles TU \times TU_P (TU_P \times TU), TU \times LP (LP \times TU) and TS \times LP (LP \times TS) some of the respondents differ in their criteria as well as their focus of decision. Thus, in a sufficiency situation either TU or TS is mainly chosen by medical students. If enough resource is available to treat all patients these students seem to either use truncated utilitarian criteria in consequences or egalitarian criteria in resources in decision making. In the first case these participants focus on minimum requirement and productivity of the patients as well as aggregate patients’ payoffs and/or own payoff. In the second case they only focus on the amount of resource to be distributed. Participants who chose TU \times LP in Sequence I focus on consequences in both decisions and take patients’ productivity factors and amounts of resources needed into account. Choosing TU they consider aggregate benefits of the patients and/or own payoff, however respect the minimal amounts. Thus, in a sufficiency situation under TU all patients will be given their minimum need and the remaining surplus is then given to the patient with the highest productivity. This behaviour is affected by utilitarian thinking. In choosing LP in a non-sufficiency situation, minimum amounts and productivities are also in the focus. In a first step the patient with the lowest productivity will be excluded. Consecutively, each of the two remaining patients receives his or her minimum amount. Furthermore, LP takes additional criteria into account. The goal to achieve payoffs as equal as possible for the remaining two patients can e.g. reached by giving more of the remaining amount to a patient with a lower productivity factor. In case of increasing resources (Sequence II) medical students who first acted in a more egalitarian way (LP) tended to be more utilitarian (TU) in a sufficiency situation. Hence, an individual may act by choosing allocation types that share a comparable focus of decision but differ in the criteria of decision dependent on available amount of resource. The most striking result in the medical sample is generated in Sequences I and II by medical students choosing allocations TS \times LP or LP \times TS, respectively. When enough resource is available those medical students only consider the amount of resource and patients’ minimum needs to distribute as equal as possible (TS). But in case of shrinking quantities of the resource decision making seems to require a focus that also takes productivity and benefit of each patient into account. This in turn affects respondents’ decision behaviour. Indeed, these participants retain some egalitarian thinking but take more properties of patients into account when a non-sufficient amount of the resource is given (LP). This effect also holds for a sequence with a first given non-sufficiency situation. In other words, a non-sufficiency situation in these cases seems to lead to a stronger focus on consequences of the decision making. These findings could be related to influences of the study of medicine. Today, in the medical health sector decreasing amounts of treatment resources are not unusual. In theory and in practical clinical situations students of medicine learn the handling of limited medical resources. They account their acting as dependent on a given situation with its special possibilities (cf. Green & Mehr, 1997; Marewski et al., 2010; Valentin, 2009). Moreover, every distributive situation in the questionnaire may be seen as a separate decision problem. These aspects could form
the background for the decision making of medical students who chose LP in a non-sufficiency and TS in a sufficiency situation. If enough of the resource is available all patients seem to be perceived and treated as equals. Here, patients’ characteristics (e.g. productivity) may have little or no influence on allocation decisions. However, in a non-sufficiency problem additional characteristics of the patients have to be considered in order to decide whom to exclude from treatment.

From the analyses of the cases TU x LP (LP x TU) and TS x LP (LP x TS) we can conclude that for these participants under restrictive circumstances patients’ characteristics have a major influence on the type of medical decision making. This may be a reason for the inconsistent decision behaviour of these students.

How can we explain the also frequently chosen utilitarian allocation principles TU x TU and TU \_P x TU among medical students? Independent of the given amount of resource participants choosing these pairs of distribution tend to account for minimum amounts and productivities of the patients as well as their own payoffs and/or patients’ aggregate benefits. These respondents seem to keep a once preferred focus in every given situation by using truncated utilitarian criteria in consequences. Their intention could be first to help every patient in giving him or her at least the minimum requirement as far as possible. If this is not possible the least productive one is excluded from treatment. But apart from minimal amounts there is a consistent priority for the most productive patient. He or she receives the total surplus of the medical resource. The consistent criterion and focus of these participants seems to be so strong that an increasing or decreasing quantity of medical resource is disregarded.

A strictly own payoff maximising decision maker who would also be purely utilitarian with respect to the three patients is only found in the sample of students of economics (see last row of Table D.1). Such respondents seem to pursue own interests in decision making. They regard the productivity factors of the patients to be treated as an instrument to maximise their own profit. Their foci and decision criteria are assumed to be egocentric in a consistent way.

4. A Mental Model for the Most Prominent Allocation Principles in Medical Decision Making

Decision making of a decision maker implies an information-processing activity (Gueth, 2000, 2001; Jungermann, 2004). The process begins with the recognition of a choice situation and ends with the implementation of the choice and the monitoring of its effects.

For our explanations of the considered decision making processes we use the cognitive model of Gueth (2000, 2001) as a normative framework to classify the possible underlying cognitions of our individuals in distributing a limited resource. Moreover, we will try to explain what kind of underlying cognitions could be assumed in the decision making processes of the most prominent allocation types. Compared to Gueth (2000) we extend
his existing well-known model by adding a primary process. This primary process contains the processing the information given in the instruction of our questionnaire.

Figure F.1 in Appendix F shows the “Integrative Model” (IM) with all situations of a questionnaire, individuals’ comparisons and the applied modules on all decision levels. This model summarises both the “Master Module” (MM) of Gueth (2000, 2001) described in Section 4.2 and our new “Extended Information Module” (EIM) presented in section 4.1. It also contains the modules “Adaptation Procedure” (AP) “New problem Solver” (NPS) developed in sections 4.3 and 4.4, respectively, and the “Ex Post-Evaluation” explained in section 4.5.

4.1 The Extended Information Module

The instruction works as a kind of information in the beginning of the decision process which is shaping a scheme of thoughts and activities. Before a participant has to decide how to allocate a given resource she has to read the instruction (the text of the instruction is presented in Appendix E). In our model written language in the form of texts and figures constitutes a structure of knowledge. By reading the instruction the reader decodes the message. Furthermore, by processing the information the reader creates an own information structure related to the distributive problem. Decoding, also named as information processing, is affected by both, several factors of the reader (e.g. previous knowledge, interests) and the text itself (e.g. layout). Previous knowledge and the existent structure of knowledge in memory constitute an enormous network of interconnected schemata (cf. Hanstein, 1993). A schema represents typical knowledge of a field of reality which relies on experiences (cf. Level 1 of Fig. C.1, Appendix C). It is further divided into several superior schemata and inferior sub-schemata. This kind of network is important for the comprehension of complex contexts like a distributive situation. It occurs by connecting previous knowledge and the new information of the text.

To summarise all the information given in the instruction we decided to develop and define a new module which we denote as “Extended Information Module” (EIM). The EIM gives information about the subsequent tasks in a given experimental situation of the questionnaire. In contrast, the MM establishes a connection to experiences in previous decision situations. It is assumed that these considerations may differ between individuals because of different experiences or cognitive skills. The two experienced situations we focus on in our study are accentuated by a dotted frame.

In Figure F.1 of Appendix F is displayed that qualitative and quantitative information of the instruction has the first impact on the mental model. This information is part of the EIM. These two categories of information impose strong requirements on the individual’s capabilities. Regarding this, the way a person perceives a given situation determines which behaviour has the highest probability to lead to satisfaction for that individual.

We assume that respondents revert to that module at all levels of decision making process whenever participants compare properties of the current task with that of previous one(s). Module EIM also includes previous experiences of our participants (cf. Gueth,
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2000, 2001). Furthermore, we assume that the EIM reflects the development of a scheme of allocation acting.
In the following we will describe the two forms of information the distributor received by reading the instruction and its application to decision making.

**Qualitative information**
Firstly, the respondent has to identify herself with the presented context, i.e. she has to develop an imagination of the distributive situations. She has to consider that she plays a role as an agent in a given situation. This process could be described in terms of an acceptance of a role (here acting as a physician) or of taking responsibility for her distributive decision and the patients’ benefit. It could be compared with a role play.

The resulting questions due to the qualitative information the distributor may have, are as follows:
- “What kind of resource has to be distributed?”
- “What kind of consequences will my decisions have on me and on others?”

**Quantitative information**
The feasible amount of the resource and the payoffs for patients and distributor provide quantitative information. The distributor has to understand the connection between the amount she spends on each recipient, patients’ minimal amounts, productivity factors and the resulting benefit for patients and distributor. Due to the quantitative information the distributor has to decide which persons to serve and how much to allocate. Furthermore, she has to consider possible consequences in case of non-treated persons or persons who receive less than the minimal amount. In such a case the acceptance of responsibility could matter. We assume that understanding as well as cognitive processing of that kind of information depends on the individuals’ cognitive abilities. In terms of Jungermann (2004) peoples’ decision making is a result of anticipating and evaluating of potential outcomes and their associated uncertainties. Due to our design the consequences of the decision are certain in a fictitious way and multidimensional in terms of the patients’ and physicians’ payoffs.
After the instruction is given, participants receive four distributive situations. By passing through the four situations the decision occurs on each stage under different conditions. In terms of cognitive psychology these situations act as stimuli. One could imagine that now a connection between stimulus and the information of the EIM is made up. At this point we suppose a transition from the EIM to the MM.

4.2 The Master Module
Every situation in the questionnaire is defined by six partly complex characteristics: the available amount of the resource, the number of recipients, minimal amount per recipient, productivity per recipient, distributional proposals as well as the possible payoffs for
patients and physician. From these characteristics a decision followed by an allocation activity will be induced.

In the following stages of the decision making process the distributor includes both qualitative and quantitative information in her decision. Furthermore, for every decision problem she may use the experience made in the previous situation(s). Thus, a cumulative impact of former single situations can be assumed. In other words, the participant has to fit the new information into the context she had created before. Moreover, we assume that the process of decision making always includes the comparison of qualitative and quantitative similarities of the current choice problem with former ones.

With the background of the given instruction a participant is confronted with the first of the four decision situations where she has to treat two patients. Due to the theoretic character of the tasks, we assume that no qualitatively similar choice problem in the behavioural repertoire exists so far. Therefore, in the following step she applies the module NPS. Within that kind of module several considerations are made that are not in our focus and will not be described in detail here. By passing through this module the decision maker develops a cognitive model in relation to her basic concerns and her decision. Due to her perception she chooses an allocation that seems to be just. Afterwards, she evaluates and stores her experience in her behavioural repertoire.

Situation 1 is now followed by situation 2 which is one of the two distributive situations we focus on. In every questionnaire the non-sufficiency problem is either presented in situation 2 or in the last situation 4 with always three patients at a time. Due to the observed path-dependency effect of the sequence sufficiency and non-sufficiency and vice versa in AFS (2012) we are mainly interested in that scarcity variation and the respectively chosen distributive principles in these two situations. As already mentioned before, we assume that the decision maker’s main considerations in situation 4 are made by comparing qualitative and quantitative similarities of the current decision problem to one that already exists in her behavioural repertoire (e.g. the solved decision problem in situation 2). Like Gueth (2008) we suppose that experiences of the past affect actual decisions by mentally representing the decision task. Thus, in our questionnaire design the decision path can restrict potential choice of action and may influence future decisions.

4.3 The Module Adaptation Procedure

The module AP will be applied if there are qualitative but no quantitative similarities between both compared three-person decision problems (see Fig. F.2 of Appendix F). By mentally comparing a new three-person problem (situation 4 of the questionnaire) with the previous three-person situation (situation 2 of the questionnaire) the participant notes that she still acts as a physician who has to solve a similar allocation task with respective consequences for the patients and herself. The characteristics of the sets of hypothetical patients are also identical in both compared situations. But a closer look at the quantitative characteristics of both allocation problems reveals several dissimilarities. For example, the amount of the available resource has decreased or increased with respective changes in achievable payoff vectors (cf. Fig. F.1 of Appendix F). Especially, an exclusion of at least one patient from treatment is necessary when the resource not
suffices to treat all patients \((q = 600)\). In contrast, in case of \(q = 1,000\) the amount of the resource suffices to treat all patients. We assume that all respondents assess these quantitative differences between the two situations as being essential. The impossibility or possibility to serve all patients could induce a change of the focus with regard to the properties of the patients.

The next question a distributor has in mind is related to the costliness of a bad decision. At this point we argue that different distributional types differ in their cognition. Type U, PM x U, PM seems neither to account for any exclusion from treatment in a non-sufficiency situation nor in a sufficiency situation as a bad decision. Economic students who chose these principles in a sequence from \(q = 600\) to \(q = 1,000\) seem not to care about the fact that some patients are much worse off than others. A similar cognitive structure is revealed by type TU x TU, and TU, TU x TU. Participants acting according to these principles retain a first chosen focus. Thus, respondents who chose U, PM x U, PM as well as TU x TU, (TU, TU x TU) seem to take their own payoff or the sum of all patients’ payoffs into account by giving most of resource to the most productive patient. Their decision is in accordance with the goal to achieve an own payoff as high as possible (U, PM) or as high as possible compatible with excluding the least number of patients from treatment (TU, TU). Their rigid distribution shows that these types attach less weight to the consequences for single patients than to their own payoffs or the maximal sum of payoffs for all patients. Moreover, they break the Hippocratic Oath which is in line with findings of Gandjour & Lauterbach (1999). In terms of our decision model this means that (truncated) utilitarian distributors rely on their existing cognitive model from the previous sufficiency (non-sufficiency) situation. They only adapt to the change of the amount of the available resource and then pass through the module MM once again. Altogether, concerning the types TU, TU, and U, PM we suppose that the decision making of these individuals is guided by their preferences on potential consequences for themselves or on a collective consequence more than on other regarding preferences on consequences for single recipients.

If the resource does not suffice to treat all patients an allocation type LP makes other decisions by applying the module AP than some constantly utilitarian thinking person. Since it is inevitable to exclude some patient, the LP type tries to choose two treated patients and looks for an allocation such that their payoffs are as high and as equal as possible. This egalitarian allocation type accounts for both, exclusion from treatment and the fact that some patients may be worse off than others. Thus, other-regarding consequences of decision making for each single patient seem to be taken into account. With respect to the sequences TS x LP (LP x TS) as well as TU x LP (LP x TU) we can distinguish two types of individuals in medical decision making. On the one hand, there are persons who always allocate in some egalitarian way. In case of sufficiency they give every patient the minimal amount and split the rest equally (TS). In case of non-sufficiency these participants still act egalitarian but in addition take other criteria (e.g. productivity) of patients into account (LP). Then there are persons who do not stay with the same general idea egalitarian vs. utilitarian in case of non-sufficiency and of sufficiency. For these distributors a non-sufficiency situation leads to more egalitarian deci-
sions (LP), whereas sufficiency situations induce truncated utilitarian thinking. Due to the fact that LP is only chosen in non-sufficiency problems we suppose this could be due to possible pangs of conscience. Especially participants who distribute equally between all three patients in a sufficiency situation (TS) also tend to aspire to fairness and justice principles in a non-sufficiency problem (LP). Altogether, respondents who choose TS x LP (LP x TS) seem to feel that a disadvantage of less productive patients is unjust. It seems that for them this would be a bad decision and therefore they try to avoid this cost as far as possible. When the resource suffices they prefer to choose a truncated equal allocation (TS). In contrast, when the resource does not suffice to treat all patients they seem to maintain their basic focus on justice. After excluding the less productive patient these respondents allocate the minimal amounts to the remaining two patients, but then look for equality of payoffs. These participants now focus on productivity by minimising the differences between the patients’ payoffs (LP).

We now describe a distributor who allocates in a truncated utilitarian way (TU) if the resource suffices and egalitarian in the non-sufficiency problem (e.g. LP). We can assume that these individuals are strongly influenced by the available amount of resource. A decision for an allocation in accordance with principle TU leads to a high payoff for the most productive patient and simultaneously to a relatively high payoff for the decision maker. This decision behaviour could be interpreted in terms of an egocentric perspective of the decision maker. However, in case of non-sufficiency an egalitarian principle is applied. That kind of distributor seems to have two “personalities”. If enough resource is available she allocates the minimal needs to all patients in a first step. Thus, she tries to salve her conscience. Selfishly and also in order to conditionally maximise the aggregate effect the distributor allocates the remaining surplus to the most productive person. In contrast, restrictive conditions lead to a change of decision behaviour. After excluding the least productive patient that kind of distributor allocates the minimum amounts to the remaining two patients. But now, in contrast to before, the surplus is given to the less productive of both patients in order to reach equal benefits for these two patients. The focus of decision on patients’ properties (here: productivities) differs extremely. Non-sufficiency of a medical resource leads to favouring the less productive patient whereas sufficiency leads to preferring the most productive one. Moreover, in a sufficiency situation the own payoff or aggregate patients’ payoffs seems to be prominent whereas in a non-sufficiency situation the egalitarian consequences matter. Compared to type TS x LP (LP x TS) we assume that type TU x LP (LP x TU) also assesses a truncated utilitarian allocation in case of non-sufficiency as a bad decision and as costly and therefore chooses LP in this case.

4.4 The Module New Problem Solver

Participants who assess e.g. allocation principle TU as costly in a non-sufficiency situation after having chosen TU in a sufficiency situation before have to solve a new cognitive problem (cf. TU x LP; see Gueth, 2000, 2001). By applying the module NPS these respondents act as a “New Problem Solver” (cf. Fig. F.3 of Appendix F).
Firstly, the participant considers what kind of basic concerns she pursues. In case a sufficiency situation was solved first she now recognises that the resource does not suffice to treat all patients. Both types, TU x LP and TS x LP, exclude the less productive patient from treatment. Furthermore, both distributional types choose a new allocation principle. Type TU is consistent in regarding the consequences of her behaviour but changes the criteria from truncated utilitarian to some egalitarian principle by choosing LP. However, in case of shrinking resource type TS still distributes in an egalitarian manner but changes her focus from resources to consequences within the basic egalitarian setup. In deciding on an allocation LP someone who has distributed with respect to TU before abstains now from her former focus on the own benefit or aggregate benefit in favour of a comparison and equalisation of single patients’ benefits under the given restriction. In case a non-sufficiency situation was presented first the allocation behaviour in a sufficiency situation either stays egalitarian but changes to the focus on resources (LP x TS) or changes to considering the own benefit resp. aggregate benefit of patients (LP x TU) not having a strong distributive concern. Having more resources available leads to treating all patients but foci and criteria might be different.

For the module NPS within the considered mental process a cognitive model will be developed that relates the basic concerns to the decision. For example, a former truncated utilitarian may be searching for a proposal that reflects her cognitions corresponding to her goals (maximising aggregate benefit of patients) in a new situation. With respect to the cognitive pathway of NPS we assume that the second analysed situation (sit. 4) is not perceived as a repeated decision task because the quantity of the resource as well as given proposals for decisions changed. Only certain characteristics of the task are similar to the previous solved situation (sit. 2), e.g. properties of the patients. In this regard recognition acts as a frugal heuristic (cf. Gigerenzer, 2001; Marewski et al., 2010).

Moreover, we also suppose that the postulated underlying adaptive processes in decision making in a new situation include various kinds of information. Firstly, the information of the decision environment (e.g. choice alternatives) matters. Secondly, the required feedback information (e.g. information about own past success) as well as the presupposed degree of rationality (e.g. what was good in the past, will be good in the future) is integrated by reinforcement learning. This statement can be extended by the assumptions of the case-based decision theory (Gilboa & Schmeidler, 1995, 2001), who axiomatically point out “...that decisions are based on the relative success of actions under similar circumstances in the past” (Gilboa, Schmeidler & Wakker, 2002, p. 483).

In our design the decision environment is reflected by the set of allocation proposals. Furthermore, the required feedback information is given by the patients’ payoffs as well as the payoff of the physician. However, the last information was not exactly available in our questionnaires since participants received there payoffs from a randomly chosen situation after the experiment. So, we suppose that decisions are made under uncertainty which leads to the application of different coping strategies (cf. Lipshitz & Strauss, 1997). However, potential payoffs were listed in the situations and we can assume that they guided the perception of consequences. There is also some empirical evidence that
this kind of uncertain information is an element often present in decision making of medical doctors (for an overview cf. Gigerenzer, 2001).

In our opinion the next question (cf. Fig. F.3 of Appendix F) is very important for the mental model approach. Like physicians our participants in their roles as physicians have to take care for the patients and to make the best medical decision. In this case “real” physicians sometimes speak about a reasonable treatment decision. In the medical health sector care for patients as well as the best feasible assistance is one of the basic concerns to be a good physician. In the module NPS the care for patients differs in two ways. Firstly, there are allocation types who only have primary concerns but do not care or only little for each single patient (cf. TU x TU, and TU x TU). Their behaviour can be described as selfish or only focussing on aggregate benefits and not on distribution of benefits. As stated before, (truncated) utilitarian people rely on their once chosen cognitive model and only adapt to changed parameters of the decision task. In terms of our mental model approach this means that (truncated) utilitarian people solely use the cognitive pathways of the Adaptation Procedure. They do not solve a new problem. Thus, they are not further regarded in the module NPS.

Secondly, some of our respondents may include both primary and secondary concerns in decision making according to availability of resource. These decision makers seem to care more for the single patients they have to treat and consider each patient’s well being. In this regard let us first turn to type TU x LP (LP x TU) and then to type TS x LP (LP x TS). The decisions of participants who chose TU in a sufficiency situation and LP in a non-sufficiency situation seem to be affected by aspiring to a relative high own payoff or aggregate patients’ benefit (primary concerns) when enough resource is available. In case of non-sufficiency they are more human by changing the allocation principle. As a secondary concern the payoff difference between the most productive patient and the patient with the medium productivity is minimised by choosing LP. Furthermore, these respondents abstain from a high own payoff for themselves in favour of the patient with the medium productivity. Thus, when non-sufficiency is given secondary concerns, i.e. further aspects, e.g. each patient’s payoff, may be included in the focus of the decision making. Secondary concerns can be represented by a category, i.e. a set of included elements where the elements are context dependent (see Henderson & Peterson, 1992). By specifying a context the relationship between an element and a category may be changed. Applied to a participant’s decision process of the above types it means the following: When distributing a given resource the distributor has the possible consequences in terms of advantages or disadvantages for every recipient in mind and evaluates them. She develops a mental account for her distributional options. Gueth (2008) affirms this statement and also states that behaviour is affected by its anticipated consequences in the future.

Moreover, we assume that some of our respondents have two concerns in mind but differ in using them dependent on the availability of the medical resource. Type TU x LP changes her focus from more selfish or aggregate oriented to individual-patient-related and distribution oriented behaviour in case of non-sufficient resources and vice versa. Due to the following cognitive paths of decision making we assume that both, the under-
lying primary concerns of TU and the predominant secondary concerns of LP, are not conflicting. We rather suppose that non-sufficiency leads to rethinking former allocation behaviour. Thus, allocation type TU chooses a reasonable distribution in form of LP under non-sufficiency conditions whereas LP selects TU when the resource suffices to treat all patients. Here, “reasonable” means that the allocation is satisfactory in view of the distributor. Due to the character of the model in the following stage the MM is entered again (cf. Fig. F.1 of Appendix F).

Altogether, people tend to withdraw a possibly egocentric perspective when the resource does not suffice and emphasise their own concerns more in a sufficiency situation. For further experiments it seems to be of high interest if allocation type TU x LP tends to chose the previous principle TU in an afterwards presented sufficiency situation in a sequence of “sufficiency – non-sufficiency – sufficiency”. We intend to test this “three-regime design” in a next experiment. If we would obtain this result, it would prove our thesis that non-sufficiency of a given resource is a strong predictor of changing more selfish and aggregate decision behaviour into more single-patient-related decision making. If we would find sequences like TU x LP x TU we could expect that there exist conflicting primary and secondary concerns. Such a conflict could be the reason for being a truncated utilitarian when there is enough resource available to treat all patients. For a distributor of type TS x LP and LP x TS respectively we suppose a comparable decision making process with respect to the pathways of module NPS. But now we have to extend this module by a third path that only includes secondary concerns. Secondary concerns predominate in cognition of these students by choosing type TS in a sufficiency situation and LP in a non-sufficiency one. In a sufficiency situation these participants seem to aim for not preferring any patient in terms of amounts of resource and abstain from a high own payoff. In a non-sufficiency situation they have to exclude someone. This problem is solved by excluding the least productive person. The egalitarian principle TS could have been applied afterwards to the two remaining patients. But because productivity has been taken into account now, a more complex egalitarian principle on consequences (LP) is chosen. All decisions do not intend to achieve a high payoff for the distributor, but focus on the treatment of all single patients. This result provides evidence for the assumption of behavioural economics that people are not only self-interested in allocating a given resource but also exhibit other-regarding concerns (cf. Gueth, Levati & Ploner, 2009). Moreover, this result could be attributed to the medical value system of the prospective physicians. According to the Hippocratic Oath the ethics of physicians prescribe a medical acting in serving invalids best, free of every conscious injustice and every misdoing. In line with the explanations before, we again suppose no conflict between the secondary concerns (cf. Fig. F.3, Appendix F). Finally, with respect to the sub-module NPS these distributional types choose a reasonable allocation in view of their cognitive model and apply the MM.

4.5 Ex Post-Evaluation

The final step in the framework of the mental model is the ex post-evaluation (cf. Fig. F.1 of Appendix F). At this point participants judge if their decision was right or wrong.
We assume that this process could be influenced by the conscience of our respondents. After the decision has been made considerations of the accuracy or quality of the decision are stored. These experiences are added to the behavioural repertoire of decision making processes. Storing new experiences will be less often the case when an allocation principle is retained (cf. U, PM x U, PM; TU x TUₚ; TUₚ x TU) but more often when a distributive principle is changed (e.g. TS x LP; LP x TS). One problem for applying this final step could be the missing direct feedback in form of a real consequence of decision making. It is uncertain what type of feedback the distributor evaluates. It could be the future monetary payoff for her and for two or three other participants in the role of patients. These payoffs would be defined by the distributor’s decision in one randomly chosen situation. However, feedback might also be evaluated from the perspective of the role as a physician. According to our questionnaire design, in reality e.g. a patient’s health would not be improved if she receives not enough of the medical resource. We designed the medical framing because we assumed that participants are able to put oneself in the role of a physician and also into the position of the particular patients. Of course, we do not know to what degree they do this. However, AFS (2012) and Ahlert, Felder and Vogt (2012) observed differences in the distributive behaviour between a medical and a neutral framing.

5. Limitations

Our study has an explorative character and our findings could suffer from our subjective examination and interpretation of the experimental data. Clearly, there is demand for more statistical evidence. We leave this to further research. To be able to observe reasons for choosing a certain allocation principle we conducted a follow-up study. Only medical students participated. We revised the questionnaire design adding new allocation alternatives observed in AFS (2012). Additionally, participants had room to state reasons for their decision making. The quantitative as well as qualitative examination of these results will be part of a new study and will be complementary to the present one. The impact of the two person situations on further allocation problems were not regarded in the present study. As already noted in section 4 it can be assumed that also experience from these previous situations influences the following decision making. The decision tasks in our questionnaires are rather complex and could have led to misunderstandings. In balancing quantitative information of the problems (e.g. allocation proposals with responding payoffs) finding a good solution for a given situation could be problematic for respondents. This is a study in the realm of bounded rationality (cf. Gueth, 2008) and we construct our model under the assumption that humans have limited capabilities to process information. We assume that decisions are dependent on cognitive effort, different levels of awareness, familiarity of the situation, experience of the decision maker as well as the significance of the problem (Jungermann, 2004). In this regard, substantial cognitive effort is only invested if the problem is complex, unfamiliar
or important. In our questionnaire design we can presume complexity and unfamiliarity, what is already sufficient to assume a substantial effort. However, we cannot be sure if the medical decision problem is important in the view of our participants. Moreover, some terms and definitions in the instructions and the questionnaire are very specific and are borrowed from economic theories. This may lead to divergent interpretations in the respective student samples, especially among medical students. Furthermore, we have to note that the results of this study cannot be generalised. We attribute that to the small sample size of our data acquisition. Therefore, the aim of further research will be to conduct new experiments with more participants in order to produce evidence for statistically significant results. In addition, effects of environmental conditions of the experiment (e.g. atmosphere in the lecture room) cannot be excluded completely, though we tried to have conditions like in an exam. For future research more controlled conditions of such experimental situations are preferable (e.g. in an experimental laboratory).

6. Conclusion

Decision making is a dynamic cognitive process. It combines different adaptive processes like aspiration formation and adaptation as well as retrospective evaluation of past experiences. Furthermore, unconscious processes can be assumed. Moreover, the decision behaviour of an individual is subjective and specific as well as influenced by both past and future experiences. Analogously to restrictive conditions in the medical health system we modelled distributive situations where a participant in the role of a physician has to treat a group of patients by allocating treatment time. In some of these situations it is possible to treat every patient, in others not all potential patients can be treated due to a non-sufficient amount of treatment time. In the second case, we defined an allocation problem that induced the necessity to exclude at least one patient from medical treatment. With respect to our experimental results a distributor of medical resources may adapt her activities according to the conditions of an allocation situation or not. She may be affected or unaffected by the degree of scarcity of treatment time in a given situation. We observed decision behaviour that was consistent and behaviour that changed across different variations of the availability of the resource. In order to capture these observed differences we distinguish three main distributive personalities. They have in common to follow the important general goal of consistency that a once chosen focus will never be changed when comparing two situations with decreasing or increasing quantities of the resource. The three types are represented by three principles that govern their medical decision processes. Under the general goal of consistency, a first chosen allocation principle can be maintained. This is the case for the first group of distributional types (TU x TU, and TU x TU). In this case (truncated) utilitarian thinking, consequence-orientation, own concerns
and a focus on aggregate patients payoffs are robust across two compared situations with different amounts of the medical resource.

Secondly, the consistency is fulfilled by some egalitarian thinking people. Their criterion is always egalitarian but the decision making changes from resource-orientated egalitarian in a sufficiency situation to consequence-orientated egalitarian in a non-sufficiency situation (TS x LP) and vice versa. Here, non-sufficiency seems to act as an activator of the productivity focus. Whenever a fair allocation (i.e. egalitarian in treating every patient and allocating equal amounts above the minimal requirements) is not feasible productivity may enter the distributive decision. In this regard, non-sufficiency seems to work as a kind of signal or key stimulus in decision making which is embedded in a stimulus-reaction-scheme of decision behaviour.

Thirdly, we find individuals who change their allocation criterion dependent on the availability of the resource (TU x LP). They display a consistent consequence-orientation and a robust focus of decision on similar aspects of the situations; however, change their criterion from an aggregate truncated utilitarian thinking in a sufficiency situation to an egalitarian decision making with respect to consequences and a stronger distributive concern for single patients in a non-sufficiency one.

By posing the problem of non-sufficient resources we designed a decision situation in which one patient has to be excluded from treatment. Our results show that this kind of situation leads to a consequence-orientation and also to a focus that includes productivity. Moreover, the productivity factor seems to be a strong criterion for deciding which patient will be excluded from treatment. It is always the patient with the lowest productivity of treatment who in our situations simultaneously needs a relatively large amount of the resource who is excluded. The fact that someone has to be excluded from medical treatment appears to have a very important influence on decision making, especially for medical students. Their Hippocratic Oath seems to cause a moral conflict in medical students when a non-sufficiency problem is presented first. We interpret the choice of an egalitarian principle in the form of TS in the following sufficiency situation as an evidence for the pursuit of a solution to this conflict and as a recreation of justice.

Furthermore, we want to emphasise that the two examined truncated types of distributors (TU vs. TS) differ in their cognition in relation to the characteristics of the patients. Thus, a truncated utilitarian makes a decision dependent on the individual minimal requirements, productivities and aggregate payoff of all patients. In contrast, a distributor of the type truncated split seems to regard the three patients independent of their productivity. She prefers to allocate in consideration of the minimal amounts and of the available amount of resource.

In this study we classify sequential distributive principles in a mental framework and offer a model of the underlying cognitions. However, in our design the participants’ reasons for their decisions are not directly accessible. The ascription of corresponding cognitive structures of the brain is a new research field which could give answers to these questions. For example, recently published results of neuroscience deliver insight into the corresponding neuronal and brain structures of decision making (de Martino, Dharshan, Seymour & Dolan, 2006; Sanfey, Rilling, Arons, Nystrom & Cohen,
A future research focus could be the integration of such results in theoretical mental models. Moreover, we plan an examination of the validity and generalisation of our mental model in other questionnaire designs.

The mental model approach of Gueth (2000, 2001) is comparable to the image theory of Beach (1990, cited by Jungermann, 2004, p. 572). In this theory it is assumed that in a decision task people examine whether a new option is compatible with their goals, also called images. If so, the option is accepted and implemented. If not, in a stepwise process other options and alternatives are searched and explored. If there is more than one remaining option the best one with respect to own goals is chosen. In the cognition processes of the mental model primary or secondary concerns in taking care for the patient(s) or the costliness of a bad decision are examples for this kind of choice between different allocation principles. When participants are confronted with several options, firstly, they seem to screen out which one is compatible with their goals. For example, in case of a sufficing resource a former truncated utilitarian in a non-sufficiency situation (TU_p) may refuse an egalitarian principle (TS) in favour of TU. This type of distributor is characterised by egocentric thinking or by her focus on aggregate benefits for all patients resulting in corresponding goals. Compared to Marewski et al. (2010) we denote her decision behaviour as a fast heuristic. In case of TU x LP more options seem to be compatible in the decision making of these individuals including options that consider consequences for single patients. In this regard we suppose that non-sufficiency acts as an indicator for respondents’ balancing of given alternatives (cf. Simon, 1955).

Decision making on an allocation of a medical resource under more or less restrictive conditions in terms of availability of medical resources sometimes reveals priorities on treatment of certain patients. Productivity of treatment as a prioritising criterion works stronger under restrictive situations. In these cases a ranking of patients corresponding to their productivities is considered in order to decide which patients should be treated. Nearly all subjects exclude the patients with the least productive treatment. Furthermore, the examination of the situation dependent change in applied distributive principles shows that the influence of the degree of scarcity of a medical resource cannot be disregarded in medical decision making. We call it “scarcity phenomenon”. Thus, non-sufficiency seems to be a criterion of individuals’ decision making in medical contexts.

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References


### Appendix A

**Table A.1**
The two compared decision situations with different amounts of resource and corresponding allocations and distributional types (Sequence $q = 1,000$ to $q = 600$)

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<td><strong>a) U, PM</strong></td>
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<td><strong>d) TS</strong></td>
<td><strong>d)TE_M, TE_P</strong></td>
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<td>Allocation of time</td>
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<td>Allocation of time</td>
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<td>400</td>
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<td>200</td>
<td>400</td>
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<tr>
<td>Payoff for patients</td>
<td>Payoff for patients</td>
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<td>0</td>
</tr>
<tr>
<td>2,000</td>
<td>800</td>
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</table>

**Notes.** $q$: quantity of resource; LP: Leximin in Payoffs; TE: Truncated Egalitarian; TS: Truncated Split; TU: Truncated Utilitarian; U, PM: Utilitarian, Payoff Maximiser. Additional classification of types in the non-sufficiency situation: M: selection based on minimal amounts, highest amount excluded; P: selection based on productivity, highest productivity excluded; -P: selection based on productivity, lowest productivity excluded.
## Appendix B

### Table B.1
Sequences of allocation decisions in case of a first presented or last presented scarcity in the medical context condition

<table>
<thead>
<tr>
<th>Students of...</th>
<th>Distributional types</th>
<th>Absolute frequency</th>
<th>Relative frequency (in %)</th>
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<tr>
<td><strong>Economics</strong></td>
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<td>5</td>
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<td><strong>TU</strong></td>
<td><strong>TU</strong></td>
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<td>10.00</td>
</tr>
<tr>
<td><strong>LP</strong></td>
<td><strong>TU</strong></td>
<td>2</td>
<td>10.00</td>
</tr>
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<td><strong>TS</strong></td>
<td><strong>TU</strong></td>
<td>2</td>
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</tr>
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<td><strong>TU</strong></td>
<td><strong>TE_M, TE_P</strong></td>
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<td>5.00</td>
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<td><strong>TU</strong></td>
<td><strong>LP</strong></td>
<td>1</td>
<td>5.00</td>
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<tr>
<td><strong>TU</strong></td>
<td><strong>LU_P</strong></td>
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<td><strong>TU</strong></td>
<td><strong>U, PM</strong></td>
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<td>5.00</td>
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<td><strong>LU_P</strong></td>
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<td><strong>TU</strong></td>
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<td>5.00</td>
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<td><strong>500-300-200</strong></td>
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<td>5.00</td>
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<td><strong>TS_M</strong></td>
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<td>5.00</td>
</tr>
<tr>
<td><strong>TU</strong></td>
<td><strong>LU_P</strong></td>
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<td>5.00</td>
</tr>
<tr>
<td><strong>100-100-0</strong></td>
<td><strong>LU_P</strong></td>
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<thead>
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<th>Relative frequency (in %)</th>
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<td><em>(n = 35)</em></td>
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<td><strong>LU_P</strong></td>
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<td>5.71</td>
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<tr>
<td><strong>TU</strong></td>
<td><strong>LU_P</strong></td>
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<td>5.71</td>
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(continued on next page)
**Table B.1 (continued)**

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<th>Students of...</th>
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<th>Absolute frequency</th>
<th>Relative frequency (in %)</th>
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<th>Distributional types</th>
<th>Absolute frequency</th>
<th>Relative frequency (in %)</th>
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<td>Medicine</td>
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<td>5.71</td>
<td>(n = 34)</td>
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<td>TU</td>
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<td>5.71</td>
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<td>LP</td>
<td>300-200-100</td>
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<td>LP</td>
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<td>2.86</td>
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<td>TU_100-200-300</td>
<td>LP</td>
<td>1</td>
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<td>LP_TE_M, TE_P</td>
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<td>2.86</td>
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<td>TS</td>
<td>225-100-275</td>
<td>1</td>
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</table>

**Notes:**
- $q$: quantity of resource; ES: Equal Split; LP: Leximin in Payoffs; LR: Leximin in allocated Resources; TE: Truncated Egalitarian; TS: Truncated Split; TU: Truncated Utilitarian; U, PM: Utilitarian, Payoff Maximiser. Additional classification of types in the non-sufficiency situation: M: selection based on minimal amounts, highest amount excluded; -M: selection based on minimal amounts, lowest amount excluded; P: selection based on productivity, highest productivity excluded; -P: selection based on productivity, lowest productivity excluded.
Appendix C

Fig. C.1 The top-down approach of medical decision making

### Appendix D

#### Table D.1
Chosen principles per sequence with respecting criteria and focus of participants’ decision making

<table>
<thead>
<tr>
<th>Sequence I (q = 1,000 to q = 600)</th>
<th>Sequence II (q = 600 to q = 1,000)</th>
<th>Criteria of Decision</th>
<th>Focus of Decision</th>
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</thead>
<tbody>
<tr>
<td>TU x TU&lt;sub&gt;p&lt;/sub&gt;&lt;sup&gt;a&lt;/sup&gt;</td>
<td>TU&lt;sub&gt;p&lt;/sub&gt; x TU&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Truncated Utilitarian Criteria in Consequences</td>
<td>Minimum Amounts, Productivities, Patients’ Payoffs, Own Payoff</td>
</tr>
<tr>
<td>TU x LP&lt;sup&gt;c&lt;/sup&gt;</td>
<td>LP x TU&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Truncated Utilitarian Criteria in Consequences</td>
<td>Egalitarian Criteria in consideration of additional criteria (e.g. Consequ.)</td>
</tr>
<tr>
<td>TS x LP&lt;sub&gt;b&lt;/sub&gt;</td>
<td>LP x TS&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Egalitarian Criteria in Resources</td>
<td>Exclusive Amounts of Resources (TS)</td>
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<tr>
<td></td>
<td>U, PM x U, PM&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Utilitarian Criteria in Consequences</td>
<td>Exclusive Productivities, Own Payoff</td>
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</table>

<sup>a</sup> chosen by students of both samples; <sup>b</sup> predominantly chosen by students of medicine;  
<sup>c</sup> predominantly chosen by students of economics.*
Appendix E

Instruction of the medical context

Thank you for participating in this anonymous questionnaire study. Please read the instructions carefully. With some luck you may earn some money.

This questionnaire study investigates the treatment behaviour of physicians regarding their patients.

You have the role of a physician.

You dispose of a given treatment time, which allows you to treat 2 or 3 patients respectively at most. (In a linguistic manner male and female patients do not differ from each other.) For simplicity, the treatment success of a patient will only depend on the amount of time you spend on him. In case of treatment the patient receives a utility which is reflected by a monetary payment.

Each patient is characterised by the following two properties:

First, each patient needs a certain individual minimum quantity of treatment time for the successful completion of the treatment. If the patient receives less than this minimum quantity, healing is not possible. In the experiment, this is reflected by a zero utility for the patient.

Second, the patients will respond differently to the treatment. The experiment represents this as follows: each patient owns an individual productivity factor which describes how much utility in ECU (Experimental Currency Units) he achieves with the allocated quantity of treatment time; in medical terms it concerns valuable prognostic information on the treatment success. For each time unit of treatment, a patient’s productivity is the same, i.e. the employed time for the patient is multiplied by the individual productivity factor. The productivity factor differs between patients only.

Once you have allocated all units of treatment time, you can determine the consequences of your allocation. The experiment maps this by payoffs not only to the patients, but also to you personally. The patients’ payoffs as well as your own payoff are in ECU.

Payoffs in ECU

1. Each patient to whom you allocated at least the minimum quantity of treatment time receives a payoff equal to the allocated quantity multiplied by the productivity factor.
2. Patients to whom you allocated no treatment time or less than their minimum quantity achieve zero utility (no healing) and receive no payoff.
3. The physician (i.e. you) receives a payoff which is consistent with the sum of the payoffs that the patients experience from the treatment (provided that the patients receive at least the minimum quantity).

You have to solve several allocation problems. The group of patients consists of different individuals at a time.

You are not able to identify individuals via the numbers 1, 2 or 3 in each situation.

To help you make your decision, you can choose from several distributional proposals.

For each proposal the patients’ and physicians’ payoffs are given. Instead of ticking a distributional proposal, you may also make your own proposal.

We will randomly select six questionnaires from all collected sheets by using the code numbers. From each of these six questionnaires we will choose one of the four allocation problems at random. The first three allocation problems will be paid out for the respective physician. The remaining three allocation problems will be paid out for corresponding patients. These patients will be randomly chosen from the remaining code numbers. Payoffs are made using the rate 100 ECU = 1 Euro.
Appendix F

Fig. F.1 The Integrative Model with all situations, cognitive comparisons and applied modules on all levels of decision making.
Need for Application

Are the quantitative differences essential?
In comparison to the sufficiency (non-sufficiency) situation before:
- Which amount of resource is available for how many patients, now?
- Which distributions of treatment time are possible and how does it modifying the monetary payoffs of the patients and the own payoff?

No

Yes

Is a bad decision very costly?
- Are all minimum amounts of the patients grantable or is an exclusion of a patient from treatment necessary? Does this influence my decision?
- Which consequences are related to the decision?
- What does the distributional decision mean for the own payoff?
- Accounting for a treatment exclusion or disadvantage of a patient?

No

Yes

Relying on cognitive model for the previous sufficiency (non-sufficiency) and adapt to changed parameters; going back to Master Module!

Applying New Problem Solver!

Fig. F.2 The Adaptation Procedure for a last presented non-sufficiency (sufficiency) situation
Need for Application

Which are the basic concerns?
- Should someone be excluded from treatment? If yes, who?
- Should the same allocation principle be adopted or should a new one be chosen?
- What kind of criterion as well as focus of decision are preferred in allocating the given resource?
- Increasing the own benefit or patients' benefits?

Development of a cognitive model to relate the basic concerns to the decision!

Is this a repeated decision task?

Care for the patient(s)?

No, only primary concerns
Yes, only secondary concerns
Yes, primary and secondary concerns

Are these conflicting?

No
Yes

Dare to risk conflict?

No
Yes

Choosing a reasonable distribution in view of the model; going back to Master Module!

Choosing a reasonable compromise; going back to Master Module!

Choosing a reasonable compromise; going back to Master Module!

Fig. F.3 The New Problem Solver for a last presented non-sufficiency (sufficiency) situation
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