Chapter 3: Determining the information participants need – Methods of Active Information Search

Oswald Huber, University of Fribourg, Switzerland
Odilo W. Huber, University of Fribourg, Switzerland
Michael Schulte-Mecklenbeck, University of Bergen, Norway

Introduction

Our chapter focuses on a research question that is relevant in different areas of Psychology: in which information is an individual genuinely interested when performing a certain task. This question is important because active interest in a specific item of information is an indicator (albeit not a perfect one) that this information is utilized when the person works on the task. Tasks with information search may consist of solving a problem, constructing a mental model of a scenario, or coming to a decision. Data about the information used – or not used - in cognitive processes are central to theory development as many theories explicitly predict the use of specific types of information used, or specific patterns of information acquired (for decision making see e.g. Beach, 1990; Huber, Huber & Bär, 2009; Montgomery & Willén, 1999; Johnson, Schulte-Mecklenbeck & Willemsen ,2008; Tversky, 1972). It should be noted that people may utilize types of information which are not envisaged by a theory. Examples are risk defusing actions in traditional theories of risky decision making. Thus, the measurement of information needs and information acquisition patterns are indispensable prerequisites for a test of models. If an experimenter wants to investigate the role of probabilities in a risky choice task there are two traditional groups of methods available:

1) The experimenter directly presents probabilities varied between conditions together with other information to the decision maker and afterwards analyzes the decisions in order to determine which effect probability had on choices (input-output

or paramorphic approach). This approach, can investigate the role of a specific type of information (e.g., probability) when it is presented to the decision maker at the beginning. However, it may force the probability information on the decision maker, and it cannot be ruled out that – without presentation by the experimenter -- a person would not be interested in probability at all. Furthermore, this method does not provide information about information acquisition patterns.

2) The experimenter uses some kind of alternative × dimensions matrix. There are several operationalizations enabling an analysis of which information within a matrix a participant has inspected (and which not) and the sequence of inspections. Examples are information boards (non-computerized with cards or computerized with, e.g., Mouselab, see ch.1, or eye movement recordings, see ch. 2). Here, the problem lies in the fact that a label for a dimension has to be presented. This dimension label may cause demand effects by indicating the importance of that dimension to the decision maker. Huber, Wider and Huber (1997) found that probability information is searched much more often when the dimension label is presented to the participant by the experimenter. Furthermore, dimension labels as well as initially presented information may pre-structure a decision problem and thus may hinder the decision maker to spontaneously structure the decision problem in an alternative way, e.g. based on dimensions that are rooted in previous real-world experience.

Therefore, to investigate spontaneous information acquisition, a method is necessary that avoids the methodical limitations imposed by both traditional approaches.

Active Information Search (AIS)

As explained above, the method of Active Information Search was developed to deal with the problem of how the information a decision maker needs can be measured with as little demand effects as possible. Engländer and Tyszka (1980) identified the problem of reactivity in most decision making tasks, and designed a conversational method in multidimensional choice, where the experimenter acted as an expert whom the participant could ask for information. They did not present dimension labels in order to avoid reactive pre-structuring of the decision problem by the experimenter. Our *Method of Active Information Search* (*AIS*) (Huber et al., 1997) is an extension of this paradigm and was developed especially for risky decisions.

According to influential theories on risky decisions and experimental results, the central factors determining risky decision behaviour are: the subjective values of the outcomes and their subjective probabilities (cf., e.g., Baron, 2008). Most of these experiments, however, use (simple) gambles, or tasks pre-structured as gambles by the experimenter in testing theories that describe risky decisions in general. The underlying assumption, however, that results obtained with gambles may be generalized to all types of risky decisions is challenged by empirical results comparing decision behaviour in gambles and other risky tasks (Huber & Huber, 2008). Further tests of a broad range of theories with task types other than gambles seem therefore necessary.

If one is interested in risky decision making in general situations and not only in gambles, the prevalence of gamble-like tasks is a problem for the generalizability of risky decision theories. In order to overcome this problem, quasi-realistic scenarios were designed and used in many experiments. An example is the Turtle scenario (see Textbox). A number of these experiments have used different variants of the AIS procedure: Huber et al. (1997), Huber, Beutter, Montoya and Huber (2001), Huber and Huber (2003, 2008). Huber and Macho (2001), Ranyard, Williamson and Cuthbert (1999), Ranyard, Hinkley and Williamson (2001), Schulte-Mecklenbeck and Huber (2003), Wilke, Haug, and Funke (2008), Williamson, Ranyard and Cuthbert (2000a, b), Tyszka and Zaleskiewicz (2006). These experiments reveal decision behavior that is quite different from that displayed in choices between gambles or alternatives that are pre-structured like gambles. The main behavioral differences are:

1. If the experimental setting enables the decision maker to search actively for information about the alternatives in the decision situation, many decision-makers are not interested in probability information.[1] It should be noted that in the experiments, the decision maker is informed in the instructions that a negative outcome *may* occur. Thus, risk is made salient to the participant, but probabilities are not presented initially.

2. Often, risk-defusing behavior (see below) plays a central role in the decision process. If decision-makers realize that an otherwise attractive alternative may lead to a negative outcome, they search for a risk-defusing operator that eliminates or reduces the risk involved.

A *risk-defusing operator* (*RDO*) is an action intended by the decision maker to be performed *in addition* to choosing a specific alternative and is expected to decrease the risk. RDOs are common in everyday risky decision situations. In the Turtle scenario (see textbox below), the decision maker may suggest the following action as an RDO for alternative B: Spraying an anti-mite drug on the eggs in order to prevent infection with mites. Discovering an RDO has a crucial effect on choices. If a risky alternative can be defused with the help of an RDO, it is chosen much more often than when not (Bär & Huber, 2008). Huber (2007) presents an overview of research into factors affecting the search for RDOs (e.g., attractiveness of the alternative, expectation of finding relevant information) and the acceptance of RDOs (e.g., cost and effectiveness). Both phenomena, the low interest in probability information as well as the interest in RDOs, however, were not detected with traditional methods as they do not allow decision makers to search for information according to their spontaneous needs. In what follows, we will describe the AIS method referring to its application in research on risky decisions.

The AIS procedure

The central procedural characteristics of the AIS method are the following: The participant is presented a scenario description and usually some basic information about the alternatives (we call this step *Reading*). After reading the scenario the participant may pose as many questions as wanted to the experimenter in order to get further information (*Questions*). After each question, the participant receives a prepared answer (*Answers*). If he or she thinks to have received a sufficient amount of information, the participant decides (*Decision*).

We use two types of AIS procedures, *basic* and *list* that differ in the way participants acquire information (see below). To facilitate the presentation of the AIS procedure, in the box an example of a quasi-realistic scenario can be found we later will refer to. The basic description, (i.e. the information given to the participant initially) of the Turtles scenario presents the decision situation. In this example, there is one risky alternative (B) and one non-risky one (A). We found that it is useful to label the alternatives with descriptive terms (e.g. “beach”) instead of letters because labels facilitate memorization. Of course, all alternatives in a scenario may be risky.

The level of detail in the description of the alternatives varies dependent on the research question.

------begin box

Turtle scenario

The Hawsgeorge Turtle living in the southern pacific is acutely threatened by extinction. The last remaining turtles are held in a lab. Unfortunately, the turtles do not breed in the lab. You are the head of an international program to protect these turtles. Marine biologists have found two possible breeding places. You have to decide where the turtles shall be relocated *to*.

Alternative A: Beach.

A beach situated close to the lab would be suitable for breeding. There, the turtles are not at risk, there are no predators. However, the quality of the water is only moderate. Therefore, the reproduction rate of the turtles will be low.

Alternative B: Island.

A little island provides a perfect environment for breeding. It is also free of predators. Unfortunately, from time to time a species of little mites can occur which live in the sea. If they occur, they attack the clutch and thus kill the offspring.

------end box

*Basic AIS Versio*n

In the basic version of the AIS method, the information acquisition and coding for each individual question follows three steps:

1. Reading: The participant is given the quasi-realistic scenario. This information is the same for all participants and explicitly mentions the possibility of a negative outcome -- but no probability is provided.

2. Questions: The participant can ask questions in order to obtain more information. Note that the *participant* asks the questions, not the experimenter. The question is coded by the experimenter and the code is recorded.

3. Answers: For each question, the experimenter presents a prepared answer, printed on a card or displayed on a computer monitor.[2] The answers are printed instead of given verbally in order to enhance standardization and to avoid non-verbal influences. Usually, the answer card is removed before the next question can be posed. The participant may ask any and as many questions as wanted. Therefore, the amount and specific content of information finally available for the decision depends on the individual information needs, and different participants may have different sets of acquired information.

4. Decision: If the decision maker thinks to have sufficient information, the choice is made.

We will now present the elements of AIS in the order they are administered during an experiment.

Construction of AIS Scenarios

This section discusses the development of an AIS- scenario and the handling of problems with the categorization of questions. In order to successfully administer AIS scenarios, pre-experiments during the construction of a scenario are necessary for the development of an answer pool, the optimization of the initial task description, and to detect problems in the procedure and find solutions to them. The proper development of an AIS scenario is a prerequisite to achieve two central procedural goals: reliability and validity. The following paragraph will present critical elements of the development, during which brainstorming, the thinking aloud method, post-experimental interviews, justifications, and tests of inter-rater reliability will play a role.

Selection of the Topic. Investigating the information needs of a decision maker requires a topic that fulfills two goals: It should be, on the one hand, interesting to the participant so that he is motivated to make a good decision. On the other hand, the participant should have not much domain specific knowledge. Otherwise, she can retrieve information from memory and does not need to make an external search. In most cases, it will be sufficient to test the topic initially by informally interviewing a few participants of the same population which is later investigated. If this first examination shows people to be interested and having not too much background knowledge, it is a candidate for further use.

In our research up to now, we were interested in non-expert decision making but the AIS method can also be utilized in expert decisions (see, e.g. Kostopoulou et al., 2008). In such decisions, we expect information search to be straightforward in the sense that experts in general know which kind of information is essential for their decisions and which is not (see, e.g. Lipshitz and Shaul, 1997).

First version of basic description and preparation of answers. After having chosen a specific topic, a first version of the task description is constructed. It should contain at least the following elements: The role of the participant and a parsimonious description of the decision situation.

The description of the alternatives may vary from presenting simply the label of the alternatives to the form presented in the turtles example (see textbox). Based on this basic instruction, brainstorming by the researchers or a few participants can produce a first list of possible questions. For these questions, appropriate answers have to be generated. Each answer should be coded unambiguously into one category. This category should be appropriate for all possible questions the answer shall be given to. As during application of the AIS method only the code of the answer but not the wording of the question is recorded, the experimental procedure is facilitated for the experimenter and possibly distracting actions of the experimenter are minimized.

Optimization of the task description and of the answers. In most cases, the first version of the basic task description will have to be modified for several reasons. First, dominance of specific alternatives in the task description has to be avoided. If one alternative is clearly superior to the others in the initial description, it cannot be expected that participants ask questions concerning the other alternatives. Second, a specific fact in the basic description could be implausible (subjectively). Third, the description may be too rich, making information search, at least in part, unnecessary. Finally, the description could be too short so that the participant cannot empathize with the decision maker in the situation and hence does not ask questions.

Applying a concurrent thinking aloud procedure (cf., e.g., ch. 4) in this phase is helpful (see, e.g. Erikson and Simon, 1993). This procedure requires the participant to verbalize all thoughts while deciding with the AIS method. The session is audio taped and later analyzed. However, the analysis of thinking aloud protocols is very costly and time-consuming.[3] Alternatively, post-experimental interviews can serve a similar purpose.

The test of the task description is used also to generate a list of questions that is as extensive and complete as possible. Subsequently, matching answers can be constructed. However, for practical reasons it will never be possible to achieve a 100% complete list of questions. Therefore, in some rare cases, the experimenter faces a question to which no answer is prepared. There are two ways to deal with this problem. First, the experimenter may invent a plausible answer ad hoc and answer verbally or write it on a blank card and presents it to the participant. This procedure avoids participants getting discouraged by not getting answers, but may involve extraneous variables. Second, the experimenter may inform the participant (e.g., by presenting the appropriate printed card) that this information is not available.

Typically, the experimenter's reaction to an unexpected question will be harmless to the central research question because, in general, such questions are not aimed at a central aspect of the scenario or the alternatives (these should have been identified in the pre-experiments).

Categorization of Questions

Each question posed by a participant is categorized by the experimenter during the information acquisition process. This step is realized by matching the question to a prepared answer that has been assigned to a category of questions in advance. In general, the coding scheme serves first the purpose to capture all categories important to the models tested comprehensively, and second to capture as many of other questions that might be asked by the participants as possible.

We will present our coding scheme for risky decisions as an example which was developed investigating risky decision models. It differs from earlier versions presented in Huber et al. (1997) and Huber et al. (2001) in taking into account our newer findings. We started with the categories consequences and probabilities theoretically most relevant to some models (see, e.g. Baron, 2008) and added the RDO category (Huber, 2007). The other categories included in the following list were added to be able to complete the coding system:

1. General situational information
2. Consequences
3. Probability
4. Risk Defusing Operators (RDOs)
5. New Alternatives
6. Miscellaneous

We now describe these categories in detail. It should be noted that for specific research questions it may be necessary to introduce subcategories for categories. For example, it may be useful to distinguish positive or negative consequences.

General situational information refers to all questions which are not aimed at the alternatives, but investigate the general decision situation. These are questions concerning the background, the role of the decision maker, the circumstances of the decision, and the situation. (e.g., "How many turtles are held in the lab?", "How long does the protection program exist?).

Consequences refer to the outcomes of alternatives (e.g., "Provided the mites will occur, will all offspring be killed?", "What happens if I take the medicament instead of an operation") or to attributes of alternatives (e.g., "How much does the transport of the turtles to the island cost?", "Is the medicament expensive?").

Probability refers to a probability or uncertainty of the occurrence of the consequences. Probability questions can contain the word “probability” or “probable” (e.g., “What is the probability of….”), may involve a frequency format (e.g., “How often do the mites occur?”), but also may contain other expressions (e.g., “What is more likely…”).

Risk Defusing Operators (RDOs) refer to information concerning the control or prevention of negative consequences by actions that are executed *in addition* to choosing an existing alternative are coded as RDO questions. Two subcategories have to be distinguished: (1) A question can inquire about the *existence* of an RDO (e.g., “Can the offspring be preserved if the mites occur), or suggest a specific RDO, (e.g., “Can I kill the mites by spraying insecticides onto the sand at the beach?”), or (2) a question can search information about attributes of an RDO, such as cost, effectiveness, etc.

New Alternatives questions ask for additional alternatives not included in the presented set or propose a new alternative and ask whether this alternative is available (e.g., “Is there no possible breeding area with perfect water conditions but without the threat of mites?”). Thus, in contrast to an RDO question, a New Alternative question does not aim at an action that is intended to be performed *in addition* to an existing alternative.

Miscellaneous questions cannot be coded as one of the other types. This category is to be applied also if the target of a question is unclear for the experimenter, or, for example, a participant asks questions about the experimental procedure during the information search.

Problematic Issues during the Construction of a Coding Scheme.

To successfully develop a coding scheme for a scenario additional issues have to be addressed. We therefore have some specific remarks that can facilitate research with the AIS method. Some are concerned with the construction of questions and answers, and some with the coding during the procedure.

Construction of answers. First it has to be considered that some types of questions can be *asked separately for each alternative* (consequences, probabilities, or RDOs). It thus may be necessary to additionally code the alternative the answer refers to. Second, whereas most questions search information, some may *propose an RDO* and ask whether it is applicable (e.g., “Is there a vaccine against this disease?”). For such cases, it is necessary to define a class of RDO proposals (e.g., proposals to prevent the negative outcome of an infection) and prepare answers indicating the existence or nonexistence of the proposed measure (e.g., “Your proposal to prevent infection would work well.”) for all possible proposals of the class. Third, in some scenarios, a *negative event* can be identified which by means of some causal mechanism leads to a negative consequence. In this case, the participant may ask about the probability of the negative *event*. It depends on the research question whether or not this case is treated as a separate category. Forth, the *scale level of answers* is important: For probability questions, some kinds of consequence questions (e.g., referring to possible profit, cost, etc.) or questions referring to a property of an RDO (e.g., cost), the experimenter can provide a precise answer (e.g., the probability is 80%) or an imprecise one (e.g., the probability is high). For example, Huber et al. (2001) were interested in the degree of precision a participant was satisfied with. They instructed participants that they could demand a more precise answer if a given one was not satisfying. After the first question they gave only an imprecise answer and only after further questions a precise one. They found that only 7% of those people asking for probabilities demanded a precise value. Fifth, the answer to a New alternatives question usually should be negative. Otherwise the decision maker may invent new attractive or even dominating alternatives Sixth, questions concerning RDOs may address the *existence* or the *properties of an RDO* (e.g. cost, or effectiveness). The latter type in general can only be posed after the existence of an RDO has been asked for. It is necessary to construct both types of answers in advance. Regarding the analysis, both types may be pooled if the research question concerns only the fact whether a decision maker is interested in RDOs or not.

Procedural Issues. In this paragraph we will address issues that can emerge during the data collection process. First, decision makers may *ask the same question category for the same alternative repeatedly* (e.g., “What are the consequences of alternative A?”,…, “Are there other consequences?”). It has to be determined in advance if such repetitions (e.g. due to forgetting) are taken into account for the analysis of the data. Second, participants may *ask for facts already described in the basic instructions*. For such cases, it is necessary to prepare answers that confirm these facts. Third, some people *do not ask separately for positive and negative consequences* (e.g., “What may happen if I chose …?”). If the researcher is interested in that distinction, the following procedure is recommended. If a participant asks for the consequences of an alternative, the first answer is that there are positive and negative consequences. Then, in the next question, participants may ask specifically for positive or negative consequences. Finally, any questions that *can not be assigned to a standardized answer* should be recorded so that they later can be analyzed. The same holds if a participant proposes for example, a specific RDO.

Procedural Previsions for Unclear Questions. Sometimes, the experimenter is confronted with unclear questions. Some cases can be isolated for which the procedure has to be standardized:

1) The experimenter does not know whether a specific answer is appropriate or not. In this case, she can ask the participant for a more precise or reformulated question.

2) The participant asks more than one question at a time. Here, the experimenter can either present the first respective answer, or ask the participant to reformulate the question.

3) The case of comparison of aspects is of special importance. Questions like 'Which one is more expensive, A or B?' concern both alternatives. Here, either one directly fitting answer can be presented, or the answer to the cost of A or of both alternatives.

Test of the reliability of the coding system. The reliability of the coding of questions (and answers) is crucial for the administration of the method and the validity of the results. Therefore, the inter-rater reliability (e.g., Cohen's kappa, Cohen, 1968) of the coding system should be tested not only for the final version but also earlier during the development process. A low reliability can indicate a still insufficient coding system.

Statistical Analyses

The result of an AIS procedure consists of an ordered list of questions asked by the participant, and the final decision. These raw data may be analyzed differently in order to answer research questions on (1) the quantity of information search in total or for specific coding categories, (2) sequential aspects of information search, and (3) the specific choices as a function of information search.

The main dependent variables with respect to the quantity of information search are: total number of questions, and number of questions for the respective categories of interest. With respect to the sequence of information search, the order of the questions is the basis for several dependent variables. For some research questions it may be of importance which coding category is asked first, last, or whether a specific question category is asked before or after another category (see, e.g., Huber et al. 2009). In these cases, for each of the questions a dependent variable may code the respective aspect categorically. If the occurrence of a specific category within the search stream is of importance, the sequential position of each question of the respective category of each subject may be coded (e.g., 1st, 3rd, and 6th), and the mean sequential position may be computed for each subject (e.g. 3.34).

For the analysis of numbers of questions, or of the mean sequential position of specific questions, parametric analyses as ANOVAS are desirable as they provide high statistical power and are available for multiple designs including repeated measurement designs with multiple independent variables varied within subjects. However, in some cases the dependent variables (e.g., the number of RDOs) do not fulfill the scale and distribution requirements for parametric analyses. This is especially relevant when the research question addresses specific question categories. Here, two problems frequently occur: 1) The amount of questions may be zero for a part of the participants and very small for the others (e.g., probability questions), or 2) a subset of participants asks the same type of questions repeatedly, whereas others do not ask that type at all (e.g., RDO related questions). In both cases, mean numbers of questions could give a biased picture. Here, standard Mann-U or Wilcoxon tests (Wilcoxon, 1945) may be administered. We recommend, however, the transformation into categorical data signifying if the participant did ask any questions of the respective category or not. Then one can compute, for example, what percentage of participants asked at least one probability question in a specific choice task. Logit analyses allow for the concurrent analysis of several factors varied *between* subjects. A logit analysis performs statistical tests by fitting a hierarchy of logit models to the data (see, e.g., Agresti, 1990; DeMaris, 1992) thus enabling the identification of effective factors. For factors varied *within* subjects, standard Sign and Cochran's Q tests (see, e.g. Agresti, 1990) may be appropriate.

For some research questions one is interested in the specific choices as a function of information search. For example, one can investigate whether a specific alternative was chosen more often if the decision maker searched for probability information than if he or she did not. In this case, the specific question category is treated as independent variable in respect to decisions, and statistical analyses with categorical dependent and independent variables are suitable (e.g. Logit analyses, Agresti, 1990).

List version of the AIS Method

In contrast to the basic AIS procedure described above, in the list version the participant is presented a list of questions. He can select one question at a time that is answered by the experimenter. A question may also be posed repeatedly. Table 1 contains a list of questions that can be used for many scenarios.

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Table 1 about here

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The sequence of answers fitting a specific question may be randomized or kept constant. Dependent on the research question, the participant can be given the opportunity to additionally ask questions that are not on the list.

The main advantage of the list version of AIS is that the questions do not have to be coded by the researcher during the experimental session, thus the experimenter's burden is facilitated. On the other hand, the list of questions pre-structures the scenario for the participant and also may alert her or him to a specific aspect. For example, a participant may have not thought about an RDO beforehand but – when he reads the RDO question – she may begin to think about this possibility. In this respect, the list version is similar to the alternatives X dimensions matrix of multidimensional decision making. The list version can easily be computerized and thus can be used also in an Internet experiment (Schulte-Mecklenbeck & Huber, 2003; see below).

Cost of information.

In the list version, the problem may occur that some very few participants first simply ask all available questions (one after the other) and later start to process the answers. To prevent this course of action some cost can be introduced for each answer the participant gets. Cost can be monetary, but can also be computational. For example, cost can be introduced by presenting the answer cards only until the next question is asked and thus forcing the participant to process answers directly. It is also possible to limit the total number of questions asked. We recommend the latter procedure if the type of information being most important to the decision maker is investigated. If the procedure is computerized, a type of cost can be introduced easily by increasing the time lag between the question and the answer.

Hierarchical List Questions.

If questions are very specific, the list can become very long. If the list of questions is too extensive, the participant may not be able to work with it. A solution to this problem is the introduction of hierarchical questions: a specific question (or group of questions) is presented only if the participant has asked another particular question before.

For example, the participant asks the RDO question

"What can I do to prevent the negative consequences in breeding place B?"

and receives the answer

"You can use a natural poison to destroy the salt water mites".

Then the following questions are presented (the participant is instructed that he may or may not ask additional question):

"How expensive is this measure?",

"How effective is this measure?",

"Is this poison dangerous to other animals?",

etc.

In a face to face experiment with the list version, the hierarchical version may be too demanding for the experimenter. It is, on the other hand, particularly adequate for a computerized version. It should be noted that in the basic AIS-version, participants usually pose questions in a hierarchical manner spontaneously, i.e. after having asked for a specific subject (e.g. an RDO), they often ask about properties or details of it.

Comparison Basic and List Version

Huber et al. (2001) experimentally compared the basic AIS-version with the list version. In the list-version, participants asked a higher total number of questions and specifically more questions in the categories “probability” and “RDO”. Therefore, the authors conclude that despite this reactive effect the list version can be used if not the absolute occurrence of different categories of questions is of interest but a comparison of the frequency of specific types of questions (e.g., RDO), for example, in different experimental conditions.

Computerized versions of AIS

The basic as well as the list version of AIS can be transformed into a computer program. Such a computer program can operate under the supervision of an experimenter, or run an experiment without human help. The experiment can be administered in the laboratory (on a networked computer) but also on the Internet. We do not want to discuss advantages and disadvantages of Internet based experiments here, such discussions can be found in, e.g., Reips (2000) and Birnbaum (2004). We will now give two examples for online AIS experiments.

AIS in the Chat-Room

The basic AIS version may be applied without any programming effort via internet with chat programs enabling communication in written form (e.g., MSN Messenger, Skype, ICQ), see Studer (2007). A chat program enables synchronous conferencing in real time, by exchanging text messages. Other chat program functions are not relevant for our purpose, for example, the possibility to telephone or exchange video streams.

In an AIS experiment using a chat program, participant and experimenter do not have face-to-face contact. The participant sends the questions and the experimenter responses by retrieving the appropriate answers from a set of prepared text blocks. Participants can be recruited in traditional manner, or via e-mail lists, forums, panels, etc.

In the next section, a computerized AIS version will be presented that enables the application of AIS in internet experiments without an active experimenter.

Web DecisIon Processes - WebDiP

WebDiP (Web DecisIon Processes) can be downloaded free of charge from the project's homepage: http://webdip.sourceforge.net. A detailed installation and usage description is presented on this site and in Schulte-Mecklenbeck and Neun (2005).

From the experimenter's side WebDiP provides a Web-based administration tool for setting up and managing information search experiments. Within this setup, two different search modes can be chosen: The *keyword search* is a search procedure that mimics the basic-AIS version. For the participant, a simple Web-interface guarantees easy usage. In the keyword-version, this interface is similar to a search with a common search engine on the Internet (e.g., Google). The *list search* that corresponds to the list version of AIS is built using a link-list that is best compared to a bookmark collection.

Dependent variables. One crucial difference between the classical AIS method and WebDiP is the presentation mode of the information. Remember that in the list-version a list of questions is presented to the participant who decides what information is necessary for making a decision. In contrast, in the basic-version the participant asks questions and receives answers from the experimenter. In both versions the reactions of the participant are easy to record by, e.g., taking notes or videotaping. In a Web based study it is harder to record what the participant is actually doing during the experiment.

The central behavioral dependent variable available in a Web study is a *click* on a link or a predefined area on a Webpage This click generates an entry in a database or Web server log file which can be analyzed afterwards. Furthermore, if the participant types in a number, a word or a text, this input is also stored and available for later analyses. A special feature within the data collection is the recording of a so called *timestamp* to every single action (click) within an experiment. A timestamp is the current time of an event that is recorded by a computer. It is therefore possible to calculate the time between clicks (e.g., the time between the pressing of the search button and the selection of a question) or the time one participant needs for a scenario or a whole experiment.

In terms of data analysis, WebDiP allows the export of the collected data into a CSV (comma separated values) file. Such a file can easily be imported into a spreadsheet program or statistical software package for further analyses.

Keyword version. This version mimics the information search procedure introduced in the basic AIS version and tries to overcome the problem of pre-structuring a decision scenario. The consecutive steps in the information search procedure are as follows:

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Figure 1 about here

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As a first step in the information search procedure, the participant is asked to enter a keyword (e.g., “consequences”, see Figure 1) into a text field. This procedure is familiar for many participants because of today’s common usage of search engines on the Internet. Following the input of a keyword, a list of questions is presented. This list is generated via a *full text search* within the stored questions. Given, for example, the search term “consequences”, all questions including this word on any position are displayed. It is important to note that for the generation of the questions (and answers) the same steps as described above for the AIS method are necessary.

Concerning the list of questions presented after a keyword, there are three possible reaction states for a user:

1) One (or more) of the question(s) “fit” the interest of the participant. A common reaction is to click on one of these questions (links). After clicking on the link the participant receives a text answer to the question.

2) The resulting list is very long. A common keyword like “turtle” (in the example above) leads to such a situation. Because most of the participants tend to work with the first links (the top) of the list,[4] a randomization of the presented list items was introduced.

3) In the third state the entered keyword results in an empty list. This is possible if the keyword is not covered by the scenario's information. The participant is then asked to try again with a new keyword. Through pre-experimenting, this state can be minimized. However, not all possible keywords can be covered through this method.

While working through the scenario, the participant clicks on several information items. To help participants remember which information was already inspected, every clicked-on question is displayed in a predefined area on the computer monitor (see Figure 1, "already viewed"). This area can be compared to a "shopping cart" known from online stores like, e.g., amazon.com. Simultaneously with the listing in the "already viewed" window, the selected question is erased from the results list and only the not yet inspected questions remain visible.

List search. Two versions of the list search are available. The first is the *standard list search* where the participant works with a short scenario description and a list of corresponding questions. A click on a question of interest results in the presentation of an answer in text form. Having read this answer the participant goes back to the list and selects another (or the same) question.

The second version, the *category search,* presents a short list of predefined categories first, e.g., general situational information, probability or RDO (see the list in 4). Clicking on one of the categories produces a list of questions associated to this category (by the researcher beforehand). The participant then clicks on a question of interest and receives an answer to this question.

Both versions have the advantage of making it possible to run an experiment with, e.g., standardizing reaction times to a question (a factor that will always vary when a human experimenter is used). Nevertheless, either version comes with the downside of introducing pre-structuring of the presented information again (see above).

Conclusion and Discussion

The AIS-method helps the researcher to investigate models in reasoning, judgment and decision making, or complex problem solving, by providing process measures of the type, quantity and sequence of information a participant is interested in. As at least the basic AIS version leaves the formulation of questions completely to the participants, the method does not push information onto them. Therefore, the genuine information need of the participant is measured. The method is especially useful if one wants to test the predictions a specific theory makes about information usage in a task, as well as for the test of predictions of sequential characteristics of information acquisition.

An important question is whether it is it possible with the AIS-method to identify *all* information a participant uses? The answer is *no*. If the participant introduces information stored in the long-term memory or inferred from other information, he or she may not ask for it. Bär and Huber (2008) combined the AIS-method (basic version) with a concurrent thinking aloud procedure. 29% of those participants never asking an RDO question simply assumed tacitly the existence of an acceptable RDO. This result underlines the necessity to use scenarios where the participants do not have too much background knowledge, as discussed in the *Construction of AIS scenarios* section. If, however, for theoretical reasons it is inevitable to use scenarios where background knowledge is prevalent – e.g. in expert decision making – the method should be tested in pilot studies with concurrent thinking aloud in order to identify if the measured information needs are suitable to answer the research question, or if the information central to it is generated from memory and does not leave traces in information search.

An equally important question is whether participants use the information they search for. Is seems that they usually do (provided the answer is informative to them). Bär and Huber (2008), for example, found that successful or unsuccessful RDO search (as revealed by the answer to the corresponding question) had a significant effect on the choices. Also, indirect support is available showing that actively searched information is remembered better than information presented in the scenario itself, two days after a decision with AIS (O.W. Huber, 2007). Note that AIS shares the problem of whether the searched for information is used with other methods measuring information acquisition (e.g. Mouselab).

Results of Huber and Huber (2008) corroborate the validity of the method. At least they demonstrate that, for example, the little search for probability information in many realistic scenarios is not an artefact of the AIS method. These authors compared the search for probabilities and RDOs in scenarios and choices between gambles. Whereas with the scenarios results of previous experiments were replicated (more interest in RDOs than in probabilities) in the gambling tasks the overwhelming majority of participants searched for probabilities and no one for RDOs. Equally important, Shiloh, Gerad and Goldman (2006) administered the AIS method during real counseling sessions regarding family planning for people with known genetic deficiencies. They confirmed the validity of the results with quasi-realistic scenarios showing also low interest in probabilities and high search for RDOs, and concurrently showed the applicability of AIS with real decisions.

Specific groups, like clinical samples, also raise the question of the applicability of AIS. So far, AIS has been employed with two specific groups of participants: Patients with brain damage and children. Eggen (2007) successfully administered AIS to patients with ventromedial prefrontal brain damage. While she found no basic differences in information search between these and a matched control group of healthy persons, the clinical participants displayed a tendency for perseverance in asking repeatedly the same questions more often than healthy individuals. Thus, AIS in general may be administered to clinical samples. In contrast, Belau's (2007) attempt to use AIS with children between 4 and 8 years did fail. While telling the children the basic description of the scenarios, they spontaneously produced comments and RDO proposals but did not ask any questions in the period after. Thus, we do not recommend the AIS method with younger children.

The AIS-method also helps to ease the problem of pre-structuring. In the short description of a scenario presented as the first step of the procedure, any similarity with a gamble structure can be avoided. However, it is unavoidable that some kind of structure is introduced but it can be rudimental, leaving the construction of the final representation to the participant. If pre-structuring is relevant for the research question, the structure of the short description can be varied as an independent variable and its effect thus be tested. Huber and Wicki (2004) varied the short description in such a way that the specific causal structure of the alternatives could be easy or less easy recognized. This manipulation had a predictable effect on the preference for specific RDO types.

Both, the basic AIS version and the list version have been used in several experiments. Each has its particular advantages and disadvantages:

In the basic version, no structure for the information search is presented to the participant, because he or she may formulate any question in any way. On the other hand, the burden on the experimenter is quite high: she has to categorize the questions immediately in order to provide an answer. She has also to decide critical cases (e.g. unclear questions) on the spot. In contrast, the list version has some practical advantages: (1) it facilitates the burden of the experimenter, because participant behavior is more regulated. (2) Similarly to the alternative × attributes matrix in multi-attribute decision research, it can easily be implemented in a computer program. (3) Coding is easier in the structured version, because it is done before the experiment and coding at the *participant level* is not necessary. The major disadvantage of the list version is the fact that it is more reactive because it suggests questions to the participant. On the positive side, it can be employed also under time pressure (Huber & Kunz, 2007).

In WebDiP, the above discussed AIS versions (basic and list) can be found in a computerized form called *keyword* and *list*. The keyword version clearly reduces the workload on the experimenter by automatic reactions to the entered keywords. The downside is that a computerized search does not yet have the ability to judge and act on human language (in written or spoken form) the same way humans do. This may lead to unexpected or no results for entered keywords - a fact that should be overcome by more sophisticated search engines in the future. The second WebDiP adaptation we introduced, the list version, is a close copy of the standard AIS list version and incorporates the above discussed benefits. Additionally, it enables the researcher to easily run experiments on a large scale and hence increases the power of the intended information search study.

Thus, in weighting the pros and cons of the different AIS versions, we conclude that the list AIS version (lab or computerized) can be used if the research question is not concerned with the absolute amount of information search in specific tasks but concentrates on a comparison of information needs in different experimental conditions. An example is a comparison of information search with and without justification pressure (Huber, Bär & Huber, *2009*). However, if the research question is concerned with the absolute amount of search, the basic/keyword AIS version is indispensable. An example is the research question whether or not decision makers search for probability information in a specific type of decision tasks.

We believe that with the method of AIS researchers are equipped with a tool to measure information needs of decision makers in problem solving and decision making and application of AIS experiments will promote the integration of this central aspect into the theories in the field.

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Table 1

List of questions

Question	Type of information requested
Can I learn more about the situation?	general situation
What are the positive consequences of alternative A?[a)]	positive outcomes
What is the probability that the positive consequences will occur with alternative A? [a) b)]	probability
What are the negative consequences of alternative A? [a)]	negative outcomes
What is the probability that the negative consequences will occur with alternative A? [a) b)]	probability
Can I do something to prevent the negative consequences of alternative A? [a)]	RDO
Are there other options besides A and B?	new alternative

a The same question is included for each alternative.

b Note that positive and negative consequences may occur with independent probabilities (e.g., a medicine may lead to complete healing with probability 0.7, but may entail negative side-effects with probability 0.1).

Figure Captions

Figure 1. WebDiP Search in the keyword version

Footnotes

1 The search for probability information concerning the outcome of a risky alternative is independent from whether a decision maker chooses a non-risky alternative or a risky one (Huber et al., 2001). This independence rules out the alternative explanation that people do not search for probability information because they choose the non-risky alternative anyway. Another alternative explanation would be that people do not search for probability information because they generally introduce or infer probabilities from their background knowledge. Huber and Macho (2001) showed that participants did not introduce or infer usable probability information in four different quasi-realistic tasks.

2 We found it most suitable for the experimenter if these little answer cards were attached to a larger piece of cardboard ordered by alternatives and coding category. This makes all answers concurrently visible for the experimenter and makes the handling of the answers fast. The answer cards must not be seen by the participants.

3 Thinking aloud is also helpful in the assessment of the adequacy of the specific topic. The analysis can reveal if a participant in the verbal protocol mentions mainly previous knowledge or if information search contributes to the construction of the mental representation in a substantial way.

4 In the common search engines the position of a result includes information about its relevance (the higher the position the more relevant the result is). Participants may be used to this custom through the broad usage of search engines today. It is however important to inform them that within an experiment the position of a result does not convey any relevance information.