Stimulating the Creation of More and Better Alternatives

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Abstract

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The number and quality of alternatives are crucial for making good decisions. This research, based on empirical studies of important personally-relevant decisions, examines the ability of decision makers to create alternatives for their important decisions and the effectiveness of different stimuli for improving this ability. In our initial study, participants identified less than half of the alternatives that they later identified as relevant for their decision from a master list. Furthermore, alternatives identified from the master list were more often perceived to be the best alternatives. Three other studies confirm with high significance that appropriately using objectives to stimulate the creation of alternatives enhances both the number and quality of created alternatives. These findings are consistent with results described from a real-world policy workshop to create alternatives to enhance emergency evacuation from large buildings.

Key words: creation of alternatives; identification of alternatives; multiple criteria; decision making; decision analysis; experimental
1. Introduction

Making and implementing decisions are the only means for an individual or an organization to influence the future to make things better where “better” is defined in terms of that individual’s or organization’s objectives. As any chosen alternative can be no better than the best alternative in the set of alternatives considered, an important issue is the ability of individuals to create personal or organizational alternatives (policies, options, solutions) for a given decision.

In practice, decision makers often tend to identify only obvious alternatives and usually refrain from having specific tasks focus on creating additional alternatives when existing alternatives are acceptable. Most of decision making effort is spent evaluating those readily available alternatives. Is this existing balance of effort between creating alternatives and evaluating alternatives appropriate for better achieving our objectives? This question is investigated in our paper.

We are concerned with creating a broad set of good alternatives for a decision problem. Specifically, this paper addresses four fundamental questions: (a) to what extent are decision makers able to identify alternatives for their own decisions? (b) how good are alternatives that decision makers overlook? (c) can the use of objectives to stimulate the creation of alternatives enhance the number and quality of alternatives? and (d) if objectives are useful to stimulate the creation of alternatives, how should they be used most effectively? We examine these questions with a series of four studies designed to appraise the comprehensiveness of alternatives generation in a variety of decision settings.

To our knowledge, these questions have only been cursorily studied in previous research, which is summarized in Section 2. Section 3 is an overview of our research approach. Sections 4 through 7 present four studies, each involving actual decisions of substantial importance to the participants involved. Section 8 preliminarily examines the relevance of our empirical findings in one policy application. We conclude by discussing the results, limitations, and implications of the knowledge gained for both individual and organizational decisions.

2. Relevant Research on Creating Alternatives

There are two lines of research on creating alternatives that are relevant to our research. One is methodological research that examines foundational concepts for creating
alternatives and develops procedures to implement those concepts. The other is empirical research that tests various procedures to generate alternatives in a variety of situations.

2.1 Methodological Research on Creating Alternatives

Keller and Ho (1988) characterize five approaches for the creation of alternatives. *Attribute-based procedures* rely on prior specification of the attributes by which the alternatives will be evaluated. Keller and Ho point out that the principal strength of a person's information processing system is the complex associative memory in which small cues or attributes can lead to retrieval of complex associations, which stimulate the alternative-generating process. Hence, attention to different subsets of attributes could lead to the creation of different alternatives. *State-based procedures* depend on the prior determination of states of nature or combinations of probable events that may affect outcomes of the decision alternatives. Analogously to using attributes, one could concentrate on one state at a time to create alternatives. *Composite procedures* rely on specifying both the attributes and the states of nature. This is particularly useful for enlarging a set of alternatives after a preliminary model of the problem has been built. *Alternative-based procedures* use previously identified alternatives and/or their characteristics to design new alternatives that improve relatively weak aspects of the existing alternatives and maintain or even enhance already strong aspects. In addition to these structured techniques, Keller and Ho mention general *creativity techniques* such as brainstorming can be applied (see, for example, Ackoff, 1978; and Adams, 1979).

Another framework for creating alternatives is provided by value-focused thinking (Keeney 1992). The paradigm of this method is that values, meaning what one hopes to achieve by making a given decision, provide the basis for interest in a decision problem. Therefore these values should guide our effort on solving that problem. Value-focused thinking provides numerous guidelines using values to aid the search for more and better alternatives. The principle is to create alternatives that are particularly appealing for achieving at least one of the values specified for the decision situation. In other words, one thinks first on what is desired and then on alternatives to obtain it.

2.2 Experiments on Creating Alternatives

Pitz et al. (1980) tested seven different conditions to stimulate participants creating alternatives, including showing one objective at a time, showing two objectives at the same time, and showing a whole set of objectives at once. The participants were recruited from a
course in introductory psychology. Participants stimulated by one objective at a time created significantly more alternatives than participants in the other conditions. This result can be explained by the competing implications of the stimulating and constraining effects of objectives in creation of alternatives. On the one hand, an objective inspires an individual to think how this objective could be achieved, which supports the creation of alternatives. On the other hand, when an alternative does not help achieve a stated objective, an individual feels that it is not an appropriate alternative. Thus, when an individual considers multiple objectives simultaneously, fewer alternatives may seem to be appropriate.

Jungermann et al. (1983) analyzed the effect of goal explicitness in creating alternatives. In an experiment on alternatives for a vacation, the investigated effect of goal explicitness was varied by the detail of presented goal hierarchies. Over 130 students, nurses, secretaries, or post office workers were stimulated by seeing only the top-level objective "I want to have a nice vacation", the top-level objective and the second-level objectives “To recover” and “To engage in some activity”, or the complete hierarchal structure including the third-level objectives “Recovering physically”, “Relaxing mentally”, “Doing some sports”, “Pursuing hobbies”, “Improving my education”, and “Hiking and sightseeing”. The number of alternatives generated increased with the degree of goal explicitness. Jungermann et al. concluded that an increasing degree of goal explicitness supports the creative search process of the individuals.

Gettys et al. (1987) analyzed the ability of individuals to create alternatives to solve decision problems. In an experiment, 60 introductory psychology students were instructed to create as many alternatives as possible to solve the parking problem at the university. Their self-generated alternatives were compared to a hierarchically structured model of alternatives for solving the parking problem developed by the experimenters. Although subjects were capable of generating several alternatives that might be worth taking, their suggestions were far from being complete compared to the set of alternatives defined by the experimenters. This study suggests that individuals by themselves are not able to generate a complete set of alternatives to solve a specific problem that is not their own.

Butler and Scherer (1997) examined the effects of presented objectives on quantity and quality of created alternatives. They instructed 129 undergraduate and graduate students enrolled psychology courses to create as many alternatives as they could for a sexual harassment problem and for an employee compensation problem. The experimenters created two broad objectives for each problem. The participants were stimulated by one
objective at a time, both objectives simultaneously, or were not explicitly stimulated with objectives. The quality of the alternatives was evaluated by two experimenters who analyzed the extent to which an alternative resolved conflicting facets of the problem. For the sexual harassment problem, participants stimulated by one objective at a time created more alternatives than participants stimulated by either two objectives simultaneously or not explicitly stimulated by objectives. For the employee compensation problem, participants stimulated by one objective at a time created more high quality alternatives than participants not explicitly stimulated by objectives. For the sexual harassment problem, stimulation by one objective at a time enhanced the number but not the quality of alternatives, whereas for the employee compensation this stimulation enhanced the quality but not the number of alternatives.

Selart and Johansen (2011) conducted an experiment using 70 human resource employees from a resource management department of a large organization in Sweden. The employees were asked to make suggestions about how a minor amount of money (around 3,500 dollars) could be saved by the organization during the forthcoming budget year. One of two groups of participants was stimulated with a set of seven goals provided by Selart and Johansen, while the other group was not. The participants in the group not stimulated with goals created more alternatives. The authors explain this result by suggesting that the participants who were stimulated with goals are not used to using goals to create alternatives. Furthermore, Selart and Johansen found that the participants stimulated with goals created better alternatives, as indicated in terms of creativeness as evaluated by the researchers.

3. Overview of the Presented Research

Previous empirical research on creating alternatives mainly consists of individual experiments with a descriptive focus on whether changes in the procedure to generate alternatives can affect the number or quality of alternatives generated. Our four studies, as a group, have a prescriptive focus on what individual and organizational decision-makers should do to create more and better alternatives. In addition, previous experiments had participants creating alternatives that were realistic, but hypothetical, to the participants. In other words, the participants in previous experiments were not personally facing the experimental decision situation. In each of our four studies, the participants were decision makers personally facing the decision situation and the consequences of the chosen
alternatives were potentially significant to those participants. Table 1 provides an overview of key aspects of our studies.

Table 1: Overview of Our Studies.

<table>
<thead>
<tr>
<th>Study I</th>
<th>Study II</th>
<th>Study III</th>
<th>Study IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decision situation</strong></td>
<td><strong>Decision situation</strong></td>
<td><strong>Decision situation</strong></td>
<td><strong>Decision situation</strong></td>
</tr>
<tr>
<td>Enhance benefits from a student</td>
<td>Enhance personal benefits of higher</td>
<td>Choose an MBA internship</td>
<td>Obtain an attractive academic</td>
</tr>
<tr>
<td>internship</td>
<td>education</td>
<td></td>
<td>position</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
<td><strong>Participants</strong></td>
<td><strong>Participants</strong></td>
<td><strong>Participants</strong></td>
</tr>
<tr>
<td>201 students enrolled in</td>
<td>313 students enrolled in</td>
<td>295 MBA students in the</td>
<td>45 PhD students and post docs of</td>
</tr>
<tr>
<td>business related courses of</td>
<td>business related courses of study in Germany</td>
<td>United States of America</td>
<td>an international summer program</td>
</tr>
<tr>
<td>study in Germany</td>
<td></td>
<td></td>
<td>on decision making</td>
</tr>
<tr>
<td><strong>Main parts of the study</strong></td>
<td><strong>Main parts of the study</strong></td>
<td><strong>Main parts of the study</strong></td>
<td></td>
</tr>
<tr>
<td>1. Create alternatives</td>
<td>1. List objectives (group 1) /</td>
<td>1. Create alternatives</td>
<td>1. Create alternatives</td>
</tr>
<tr>
<td>2. Check alternatives</td>
<td>sources of information (group 2)</td>
<td>2. Create alternatives</td>
<td>(group 1 see list of objective,</td>
</tr>
<tr>
<td>3. Map alternatives</td>
<td>2. Create alternatives (group 1 vs. 2)</td>
<td>3. Create additional alternatives (group 1: use</td>
<td>group 2 not)</td>
</tr>
<tr>
<td>4. Evaluate alternatives</td>
<td>3. Create additional alternatives (5 different stimuli)</td>
<td>4. Evaluate alternatives</td>
<td>2. Evaluate sets of alternatives</td>
</tr>
</tbody>
</table>

Study I investigates the research question “Are decision makers aware of their alternatives?” It involves the important decision about how to benefit most from an internship using a sample of bachelor and master students who recently dealt and/or will deal with this decision within the next few months. Prior to the study, we created a master list meant to include all possible alternatives that any participant might consider to better achieve his or her objectives during an internship. In the study, participants first listed as many personally relevant alternatives as possible. Next, participants checked all alternatives relevant to them on the master list. The checked alternatives provide a complete set of the alternatives that the participant considers appropriate for his or her own decision. We do not include any alternatives in an individual’s full set that experts consider relevant if the participant does not consider them to be relevant. Third, a mapping of the alternatives initially listed to those checked allows us to distinguish between self-generated and recognized alternatives. A main result of Study I is that the decision makers were only able to identify about one third of their relevant alternatives. This result motivates our other studies concerning how individuals can be supported to create more and better alternatives.
Study II addresses the research question: “Do objectives help to create more and better alternatives?” This study deals with the important decisions about educational focus and extracurricular development that students could pursue during their university time to enhance the benefits of their higher education. First, one group of participants was asked to list their objectives and then use the set of objectives to create a list of alternatives and the other group was just asked to list their alternatives. Subsequently, all participants were reorganized into five groups. Four groups were stimulated with different sets of objectives to create additional alternatives while one group was not explicitly stimulated by objectives. In both stages, the self-evaluated perceived quality of the initial and additional alternatives was higher for the group stimulated by objectives. However, in the first stage, participants using objectives did not create more initial alternatives than the group without objectives, but in the second stage, those using objectives did create more alternatives. An obvious explanation is that the participants in the first stage did not know how to use the objectives and therefore could not create more alternatives.

Study III addresses the research question: “How should objectives be used to create more alternatives?” This study involves the important prospective decision facing MBA students of enhancing the benefits of an upcoming summer internship. Participants first created a list of their alternatives followed by listing the objectives of their internship. Then, participants were divided into two groups. All participants were asked to create additional alternatives using their own objectives as a stimulus. One group was given the additional information to use their objectives one at a time. Individual’s given guidance to use their objectives one at a time create substantially more alternatives.

Study IV focuses on the research question: “Do objectives help to create a better set of alternatives?” The context is the important decision for many PhD students and post docs concerning what they can do to obtain an attractive academic position. Using participants in a two week international summer program on decision making, one group of participants was stimulated by objectives to create alternatives the other group not. Later all participants evaluated randomized pairs of sets of alternatives, one that was created by a participant stimulated with objectives and the other set of alternatives was created by a participant not stimulated with objectives. The sets of alternatives created with objectives were more often preferred.
4. Study I: Are Decision Makers Aware of their Alternatives?

This study is an initial examination of our hypotheses that individuals fail to generate important alternatives during contemplation of a significant personal decision.

4.1 Methods

4.1.1 Participants and Design. The participants were 201 full-time bachelors or masters students enrolled in business related courses such as Business Administration, Media and Business, and Industrial Engineering with Business Studies in a mid-sized German university. Overall, 188 participants completed the study in an average of approximately 25 minutes. The responses of 13 participants, who spent less than eight minutes on the study, are not included in the results. The 100 male and 88 female students spread evenly across the courses of study and degrees. On average, the participants were 22.9 years old. The study took place during the spring semester and participation was promoted in lectures and electronically using mailing lists and Facebook. The incentives for the participants were a three Euro voucher for a coffee, a chocolate bar, and a lottery ticket for a signed book.

The study utilized a questionnaire administered electronically in German with Qualtrics®, which also measures the time spent by participants on single tasks. To avoid external influences, the study took place in reserved computer rooms supervised by trained operators. The participants were instructed not to communicate with others during the study.

4.1.2 Material and Procedure.

The decision problem “How to benefit as much as possible from an internship” is one that affects the participants personally. Indeed, most German university students face this decision at least once during their studies. In curricula concerning business studies, students are often required to carry out one or more internships to graduate. These internships are typically done in business, non-profits, or government organizations. An internship should provide practical experiences for the student and help him or her in his or her professional orientation process. The students should learn many aspects about a job in the selected environment and find out whether they are interested in working fulltime in this job after graduation. Companies use internships as a recruiting tool as they get a thorough impression of the interns.

Prior to conducting this study, experimenters created the master list of alternatives given in Table 2. Each alternative in this table could be thought of as a very narrowly defined
category of alternatives. The intent of the master list was to be broad enough so that almost all of the alternatives created by participants in this study would be included in the alternatives on this list.

The experimenters used two different approaches and two preliminary studies to create the master list of alternatives. In one preliminary study, 20 participants listed their alternatives under the conditions of step 1. Independently, the experimenters adapted the master list of objectives for choosing MBA internship in Bond et al. (2008) to the decision situation and created at least one alternative to achieve each objective that was deemed relevant to the situation of German students. This procedure ensures a broad set of alternatives. The two lists of alternatives were aggregated into a draft master list. In this process, redundancies were eliminated and similar alternatives combined into a more broadly defined alternative. This draft master list of alternatives was used in a second preliminary study of 20 students. Their feedback was used to compile a final master list that contains 31 alternatives, labeled consecutively with the letters “A” through “EE”. The translated final master list of alternatives is presented in Table 2.

In addition to the substantive study, the questionnaire first asked participants to provide general information about their course of study, gender, age, decision behavior, and internships. The study consisted of four steps. Its design was analogous to the design used in Bond et al. (2008), who investigated whether individuals are aware of their objectives in important decision situations.

In step 1, participants were asked to imagine that they have just accepted an offer for an internship. Each participant was instructed to list all alternatives that he or she could think of in order to benefit as much as possible from this internship. The screen provided 20 blank lines on which participants could list their alternatives.

In step 2, a master list of possible alternatives to enhance the benefit from an internship was presented. Participants were instructed to check the box next to any alternative that they consider relevant for their personal decision.

In step 3, the participants matched their alternatives generated in the first step to the alternatives that they checked in the second step. For each match, participants wrote the corresponding letter of the alternative on the master list next to the alternative personally generated in the first step. The participants assigned “1” to their self-generated alternatives they could not match with an alternative in the master list. In order to ensure that the participants mapped their alternatives as accurately as possible, they were instructed to
assign one and only one letter to each self-generated alternative. In the few cases when a participant assigned more than one letter, we considered only the first.

Table 2: Master List of Alternatives for Enhancing Benefits from an Internship (translated from German).

<table>
<thead>
<tr>
<th>A</th>
<th>use own capabilities</th>
<th>P</th>
<th>take advantage of opportunities to present oneself</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>take over interesting and responsible tasks</td>
<td>Q</td>
<td>use options to enhance skills (workshops, trainings)</td>
</tr>
<tr>
<td>C</td>
<td>ask superior for a project or a task</td>
<td>R</td>
<td>ask colleagues and superiors for feedback</td>
</tr>
<tr>
<td>D</td>
<td>suggest own field of activity</td>
<td>S</td>
<td>search for information relevant for career opportunities</td>
</tr>
<tr>
<td>E</td>
<td>ask for special support</td>
<td>T</td>
<td>gain experience in different divisions</td>
</tr>
<tr>
<td>F</td>
<td>stand out positively (behavior, working morale, flexibility, etc.)</td>
<td>U</td>
<td>change internship placement</td>
</tr>
<tr>
<td>G</td>
<td>establish and deepen contact to superiors</td>
<td>V</td>
<td>reflect oneself critically</td>
</tr>
<tr>
<td>H</td>
<td>participate in leisure activities with colleagues</td>
<td>W</td>
<td>ask questions in cases lacking clarity</td>
</tr>
<tr>
<td>I</td>
<td>play a part in teams</td>
<td>X</td>
<td>participate in meetings, negotiations, conferences</td>
</tr>
<tr>
<td>J</td>
<td>contribute to a good working atmosphere</td>
<td>Y</td>
<td>work effectively and efficiently</td>
</tr>
<tr>
<td>K</td>
<td>make suggestions for improvement</td>
<td>Z</td>
<td>improve language skills</td>
</tr>
<tr>
<td>L</td>
<td>assume responsibility in a project</td>
<td>AA</td>
<td>work overtime</td>
</tr>
<tr>
<td>M</td>
<td>give constructive feedback on occasion</td>
<td>BB</td>
<td>discover culture, region, city</td>
</tr>
<tr>
<td>N</td>
<td>seek for challenges actively</td>
<td>CC</td>
<td>get a professional internship certificate</td>
</tr>
<tr>
<td>O</td>
<td>search for open positions</td>
<td>DD</td>
<td>gain experience in a particular division</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EE</td>
<td>gain experience in professional life</td>
</tr>
</tbody>
</table>

In step 4, the participants evaluated the quality of all of their personally generated or checked alternatives. Four separate measures were used to develop a comprehensive, multi-facetted evaluation of the quality of each alternative. The *suitability* of an alternative to achieve one’s objectives was evaluated using a 9-point-Likert scale from (extremely bad = 1) to (extremely good = 9). The supplement “to achieve one`s objectives” was used to ensure an individual measure. The *creativity* of an alternative was evaluated using a 9-point-Likert scale from (extremely low = 1) to (extremely high = 9). The *effort to implement an alternative* was evaluated using a 9-point-Likert scale from (extremely low = 1) to (extremely high = 9). A *ranking* of the alternatives indicating the relative likelihood that the participant would use them in their next internship. To reduce potential biases in the evaluation, the participants were presented a randomized list with all alternatives without
indicating whether an alternative was generated in the first step or only checked in the second step. The ranking was elicited using a “drag and drop” procedure in which the participants could draw the alternatives from the left to a ranking on the right. Furthermore, participants could easily conduct changes in the ranking.

4.2 Results

4.2.1 Was the Self-Generation of Alternatives Complete? On average, participants listed 7.44 alternatives in the first step; the maximum number was 20. On average, 15.41 alternatives were checked on the master list as relevant. For each participant, self-generated alternatives and recognized alternatives that were only checked in the second step can be distinguished. Around 10% of self-generated alternatives were assigned to the same alternative on the master list, so participants generated on average 6.66 distinctive alternatives. Of these 1.25 were not matched with alternatives on the master list, 4.14 were matched with alternatives checked in the second step, and 1.26 were matched with alternatives that had not been checked. Subtracting the 4.14 matched alternatives from the 15.41 checked alternatives on the master list indicates that on average 11.27 alternatives were recognized.

Results clearly indicated that participants failed to generate a comprehensive list of alternatives. Compared to 0, the mean number of 11.27 additionally recognized alternatives is highly significant ($T = 25.03$, $p = 0$).

In addition, the number of recognized alternatives was highly significant greater than the number of self-generated alternatives ($T = 8.75$, $p \approx 0$). The abundance of alternatives that were only recognized at the second step indicates a significant shortcoming of participants at the generation stage.

4.2.2 What was the Quality of the Alternatives? The average suitability of alternatives was 7.00 for self-generated alternatives and 7.01 for recognized alternatives. Correspondingly, the effort to implement alternatives was evaluated on average as 4.89 vs. 4.97, the creativeness of alternatives as 4.94 vs. 5.11. The mean value analyses using a two-sided $t$-test reveals that none of these three quality measures for the self-generated alternatives differs significantly from that for the recognized alternatives.

Of the alternatives ranked 1 to 5 by each participant, 3.14 on average were recognized alternatives. Broadening the set to those ranked 1 to 10, an average of 6.5 were recognized.

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1 A description of the statistical tests used in this article and the computations of the test is found in the appendix.
Therefore, a majority of the higher-ranked alternatives were not self-generated and only identified by using the master list. Figure 1 presents the cumulative proportion of participants who either generated or failed to self-generate even one of their top-ranked alternatives. As illustrated by the figure, 56% of participants did not generate their highest-ranked alternative. Only 10% of the participants generated all of their three top-ranked alternatives and just 1% of the participants generated all alternatives in his or her top 5.

4.2.3 Is it Worthwhile to Spend Time on Generating Alternatives? On average, the participants spent about four minutes generating alternatives in the first step. The time spent on generating alternatives in this step and the number of generated alternatives is highly correlated ($r = 0.56, n = 188, T = 9.18, p \approx 0$). The more time participants spent on generating alternatives, the more alternatives they generated. Since an individual can only choose among the alternatives that he or she had identified, every additional alternative could enrich the set of alternatives. There is always a trade-off between the chance of creating a new and better alternative and the time needed to create it.

**Figure 1: Proportion of Participants Generating All or None of Their Top-Ranked Alternatives.**

Analysis of the self-generated alternatives reveals that the more suitable alternatives tend to be generated earlier. However, as illustrated in the upper part of Table 3, the average suitability of alternatives decreases only slightly as the order in which the alternative was generated increases. Only 83 of 188 participants listed the alternative they would most likely carry out without external help. Furthermore, only 50 times this alternative was generated by participants within the first five alternatives mentioned. The other times this alternative was
listed only in sixth place or later. Obviously, these participants would not have generated this important alternative if they had stopped the process of creating alternatives after listing five alternatives only.

Table 3: Average Suitability to Achieve Ones Objectives and Distribution of Ranks of Alternatives Presented for the Alternatives Mentioned First, Second, Third, etc.

<table>
<thead>
<tr>
<th>Average suitability of alternatives mentioned first to tenth</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
<th>9th</th>
<th>10th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study I</td>
<td>7.28</td>
<td>7.30</td>
<td>7.15</td>
<td>7.01</td>
<td>6.98</td>
<td>6.75</td>
<td>6.89</td>
<td>7.30</td>
<td>6.69</td>
<td>6.36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distribution of ranks of alternatives mentioned first to tenth</th>
<th>1st Rank</th>
<th>15</th>
<th>15</th>
<th>8</th>
<th>8</th>
<th>8</th>
<th>6</th>
<th>10</th>
<th>6</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd Rank</td>
<td>10</td>
<td>13</td>
<td>17</td>
<td>16</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3rd Rank</td>
<td>16</td>
<td>14</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

4.3 Discussion

Study I reveals insights regarding the capability of individuals to generate alternatives for a personally significant decision. Even though participants were able to produce a reasonable number of alternatives without external help, they were not aware of a majority of their relevant alternatives. More than half of the participants were even not aware of the alternative they would most likely implement.

One may conjecture that participants devoted inadequate effort, meaning attention and thought, in the first step and therefore did not find many later recognized alternatives. However, two arguments appear to contradict this account.

First, if inadequate effort during the generation task was driving the difference in self-generated and recognized alternatives, then participants who listed the fewest alternatives at step 1 should presumably have recognized the most new alternatives in step 2, implying a negative correlation between the quantity of self-generated and recognized alternatives. Analysis revealed this correlation to be slight, but not significantly negative ($r = -0.07$, $n = 188$, $T = 0.96$, $p = 0.17$).

Second, the ranking data reveals that almost all participants generated some alternatives that they did not consider very important to the decision (i.e., alternatives not included in their top 10). Most participants took the generation task seriously enough to list both highly
important and less important alternatives. This suggests that much of the failure to generate many and good alternatives was not caused by inadequate effort during the time spent in the generation process, but rather other factors attributable to the complexity of the task such as an incomplete cognitive representation of the decision.

About one fourth of the self-generated alternatives were not matched to an alternative on the master list. Since this high proportion may raise a question about the completeness of our master list, we analyzed and classified these 237 alternatives. We classified 78 alternatives as not meaningful for the given decision situation, including alternatives like “Meet friends” or “Earn additional money”. We identified 59 alternatives that clearly matched with an alternative on the master list, but that match was not found by the participants. These omissions could be caused by lack of motivation or attentiveness. The third class contains 99 meaningful alternatives that were not included the master list. For example, two alternatives that were each mentioned about a dozen times were “Talk with other interns about the internship” or “Balance work and life (to remain being efficient)”. This classification by the experimenters is strongly supported by the average suitability of alternatives. The average suitability of the alternatives, classified as not meaningful, was 4.21, which is significantly lower than the average suitability of the alternatives, classified as meaningful in the second (6.69) and the third class (6.33) (T = 5.61, p ≈ 0; T = 5.59, p ≈ 0). We conclude that the master list was suitable, since it covers 92% (=1153/1252) of meaningful self-generated alternatives.

Study I strongly suggests that it is worthwhile to spend more time on generating alternatives for two reasons. First, the results indicate that the time spent to generate alternatives and the number of alternatives generated is highly correlated, and the quality of each subsequently generated alternative decreases only slightly on average. Many of the highest-ranked alternatives were not found at the beginning. Second, the data show that, on average, there are no significant differences regarding the quality of the self-generated and recognized alternatives. Since more alternatives were recognized after seeing the master list than were self-generated, there are many more good alternatives to be created. As the master list was not, and perhaps could not be, complete, this factor indicates that even more unrecognized alternatives probably exist. Spending more time on intense thinking for generating alternatives may help, especially in conjunction with efforts to stimulate the thinking process of the participants.
5. Study II: Do Objectives Help to Create More and Better Alternatives?

The second study is a first test of our hypotheses that the use of the decision-maker’s objectives to stimulate creation of alternatives will help generate more and better alternatives.

5.1 Methods

5.1.1 Participants and Design. The participants were 313 full-time bachelors or masters students mainly enrolled in business related courses like Business Administration, Media and Business, and Industrial Engineering at a German university. The responses of 24 participants who did not complete the study are not included in the results. Overall, 289 participants completed the study, 146 of them were registered for a bachelor’s degree and 143 for a masters. The 143 male and 146 female students spread evenly across the courses of study. On average, the participants were 22.5 years old. The setting of Study II was the same as in Study I, conducted in German, and lasted on average approximately 20 minutes.

5.1.2 Material and Procedure. After deciding to attend a university, all German students face an important decision situation about how to enhance the potential benefits of their higher education, which is defined as the period between their high school education and beginning their first full-time job. The decisions available in this situation concern (1) how to focus one’s classroom education, including what courses to take and the effort to exert in these courses, and (2) what extracurricular activities to pursue. This decision situation is the basis for our second study.

Prior to the study, a means-ends objectives network for this decision situation was created by the experimenters for use in the study. In pre-studies 190 objectives were elicited from students for this phase of education. These objectives served as starting point for creating a means-ends objectives network. Five experts eliminated redundant objectives and, after some iteration, produced a final list of objectives contained 27 objectives. Next, each expert created a means-ends objectives network for these 27 objectives. Using these, the expert group created a commonly accepted means-ends objectives network that included the central elements of each member’s original network. In-depth interviews with pre-test students about the meaningfulness of the resulting means-ends objectives network led to small adaptations. Figure 2 presents an English translation of the final means-ends objectives network. The first layer presents four fundamental objectives. The second layer
contains means objectives that directly influence the achievement of the fundamental objectives. The third-layer contains means objectives that mainly contribute to the objectives in the second layer.

**Figure 2:** Means-Ends Network of Educational and Extracurricular Objectives of German Students During their Higher Education.

The substance of Study II consisted of three steps. In the first step, the participants were divided randomly into two groups. Group 1 was asked to write down their objectives to enhance the benefit of their higher education. Group 2 was asked to list all sources of information they consider when making decisions. Responses included talking to friends or family members, searching the internet, reading the newspaper, etc. This task was used to employ the participants of group 2 roughly as long as the participants of group 1 listing their objectives. Then the participants of both groups had to list as many alternatives as they
could that were relevant for pursuing their objectives to enhance the benefits of their higher education.

In the second step, the participants were divided randomly into five groups. All groups were informed that recent studies confirm that participants usually mention less than half of their relevant alternatives. All but the fifth group were given different stimuli derived from the mean-ends objectives network and asked to use them to generate more alternatives. Group A was given a list of the four fundamental objectives: “Enjoy life”, “Gain knowledge”, “Develop personality”, and “Lay foundation for future success”. Group B was given a list of four means objectives “Participate actively in student`s life”, “Gain professional knowledge”, “Be committed to social activities”, and “Meet the demand of labor market”. The experimenters chose those means objectives since they collectively contribute to all four fundamental objectives, and thus provide the same range of objectives for groups A and B. Group C was provided a list of all 27 objectives and group D was provided the means-ends objectives network. Group E was asked to generate more alternatives without being explicitly stimulated with objectives.

In the third step, the participants evaluated their alternatives with three of the measures previously described in Study I, the suitability to achieve ones objectives, the creativeness of an alternative, and the effort to implement an alternative. No ranking was done because the students had already implemented some of the alternatives.

5.2 Results

Group 1, which listed their objectives before creating alternatives, consisted of 146 participants. Group 2, which did not list their objectives before creating alternatives, consisted of 143 participants. In the second step, groups A through E had 60, 58, 60, 56, and 55 participants, respectively.

5.2.1 Are Objectives an Effective Stimulus to Create More Alternatives? The results of Study II are presented in

. The mean number of distinct alternatives generated by the participants of group 1 in the first step was 5.79 with a standard deviation of 3.59. The corresponding data for group 2 are 6.71 alternatives with a standard deviation of 3.74. The difference between groups is significant (T' = 2.11, p = 0.018).
Table 4: Number of Participants, Average Number of Alternatives, Average Suitability, Average Effort, and Average Creativeness for Different Stimulated Groups of Participants.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Number of participants</th>
<th>Average number of alternatives</th>
<th>Average suitability</th>
<th>Average effort</th>
<th>Average creativeness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Objectives</td>
<td>146</td>
<td>5.79</td>
<td>7.18</td>
<td>4.08</td>
</tr>
<tr>
<td>Group 2</td>
<td>Sources of information</td>
<td>143</td>
<td>6.71</td>
<td>6.95</td>
<td>4.18</td>
</tr>
<tr>
<td>Group A</td>
<td>Fundamental objectives</td>
<td>60</td>
<td>6.68</td>
<td>6.84</td>
<td>4.60</td>
</tr>
<tr>
<td>Group B</td>
<td>Means objectives</td>
<td>58</td>
<td>5.78</td>
<td>6.37</td>
<td>4.75</td>
</tr>
<tr>
<td>Group C</td>
<td>Master list of objectives</td>
<td>60</td>
<td>7.08</td>
<td>6.78</td>
<td>5.01</td>
</tr>
<tr>
<td>Group D</td>
<td>Means-end network</td>
<td>56</td>
<td>7.93</td>
<td>6.76</td>
<td>5.22</td>
</tr>
<tr>
<td>Group E</td>
<td>No objectives</td>
<td>55</td>
<td>5.02</td>
<td>6.25</td>
<td>4.39</td>
</tr>
</tbody>
</table>

In the second step, group A, which was stimulated with four fundamental objectives created on average 6.68 additional distinct alternatives and group B, which was stimulated with four means objectives, generated 5.78 alternatives. The participants of the group C, who received a complete list of the 27 objectives, generated on average 7.08 alternatives and group D, stimulated with the means-ends objective network, generated on average 7.93 alternatives. The control group E, which was not stimulated with objectives, created on average only 5.02 alternatives. Analysis of this data indicates the following:

- The participants stimulated with objectives (groups A,B,C,D) created significantly more alternatives than the participants of the control group E ($T' = 3.07, p = 0.0012$).

- The participants stimulated by the whole set of objectives (groups C and D) created significantly more alternatives than participants in groups A and B stimulated by only four objectives ($T' = 2.29, p = 0.012$).

- There is no statistically significant difference between the number of created alternatives of the participants stimulated by fundamental objectives (group A) and by means objectives (group B) ($T' = 1.33, p = 0.093$).

Most alternatives generated in steps 1 and 2, were distinctive, such as “Carrying out an internship”, “Studying abroad”, or “Working as a student assistant”. However, participants
sometimes listed conceptually redundant alternatives, such as “Carrying out an internship for car manufacturer A” and “Carrying out an internship for car manufacturer B” or “Studying in the United States” and “Studying in Canada”, i.e. “Studying abroad”. To categorize participant’s responses, experimenters created a master list of 50 distinct alternatives and treated redundant alternatives as a single alternative generated by a participant. On average, participants of group 1 generated 0.90 redundant alternatives compared to 1.34 redundant alternatives generated by group 2, a difference that is statistically significant ($T = 1.98, p = 0.024$).

5.2.2 Does the Use of Objectives Lead to Better Alternatives? In the first step, the participants of group 1 evaluated the suitability of the alternatives to achieve ones objectives as 7.18 on average, whereas participants of group 2 evaluated the average suitability as 6.95, which is significantly worse than the participants of group 1 ($T = 2.47, p = 0.0067$). On average, the creativeness of the alternatives generated by participants stimulated by objectives was 5.52 and is significant higher than the creativeness of the alternatives generated by participants not stimulated with objectives that was 5.33 ($T = 1.69, p = 0.046$). The differences in the effort required to implement an alternative between groups 1 and 2 was not significant.

In the second step, the participants stimulated with objectives (groups A,B,C,D) evaluated the suitability of their alternatives significantly higher than the participants of the control group E ($T = 3.28, p = 0.0005$). In addition, participants stimulated with objectives (groups A,B,C,D) evaluated the effort to implement an alternative significantly higher than the participants of the control group E ($T = 3.16, p = 0.0007$). The difference in creativeness between those participants who were stimulated with objectives and the control group were not significant.

5.3 Discussion

Study II presents a mixed picture regarding the effect of objectives on the capacity to create alternatives. On the one hand, in the first step, participants who listed their own objectives before generating more alternatives produced significantly fewer alternatives than those participants who did not list their objectives, but the difference was less than one (specifically 0.92) alternative on average. On the other hand, in the second step, when a rather thorough set of experimenter-created objectives for the decision was given to participants in groups C and D, they generated 2.47 more alternatives on average than group E without objectives.
There are a couple of possible explanations for why self-generated objectives were not effective in generating more alternatives in the first step of the study. First, participants who did not list their objectives before creating alternatives were asked instead to list their sources of information in decision situation. Since most participants mentioned talking to friends and to family members, the participants could implicitly consider their different viewpoints. Second, the participants were not guided on how to use objectives to create alternatives. It is reasonable to assume that the participants looked for alternatives that satisfied all of their objectives, which would lead to fewer alternatives. The higher quality of the alternatives supports this explanation.

Study II confirms an important result of Study I. Participants again demonstrated that many high-quality alternatives are missed in an initial listing of alternatives. Alternatives that were subsequently generated after additional effort in a second step were often of higher quality than alternatives generated in the first step.

6. Study III: How Should Objectives Be Used to Create More Alternatives?

The previous two studies demonstrated that (1) individual decision-makers often consider less than half of the good alternatives potentially available when making important personally-relevant decisions and (2) using objectives for these decisions can stimulate the generation of additional high-quality alternatives. This third study examines two different ways to use the objectives to stimulate the creation of alternatives.

6.1 Methods

6.1.1 Participants and Design. Participants were 295 students in the first year of a MBA program at a large eastern university in the United States. Study III, which concerns decisions to enhance the benefits of a MBA internship. It was part of a course assignment questionnaire using Qualtrics© that included also questions on other matters.

6.1.2 Material and Procedure. This study had three parts that were embedded within the questionnaire. In the first part, participants were asked to list alternatives that they could pursue before or during their internship that would enhance its benefits from the internship. In the second part, participants were asked to list all objectives of their internship and then to check all objectives on a master list that they considered relevant in choosing an internship. In the third step, conducted after several additional questions not relevant to this study, participants were divided in two groups. Both groups were asked to use their listed
and checked objectives to generate any additional alternatives that they could pursue before or during their internship to get more benefit from the internship experience. The participants in group 1 were guided to consider each of their objectives separately to generate alternatives. Group 2 was asked to carry out the same task without the additional guidance. Group 1 had 130 participants and group 2 had 165.

6.2 Result

How Should One Use Objectives to Create More Alternatives? In the first part, prior to specifying any objectives, the average number of alternatives created was 5.36. In the third part, after identifying their objectives the participants of group 1 generated on average 5.69 additional alternatives in comparison to 3.73 additional alternatives generated by the participants of group 2. Group 1, which uses objectives one by one to create alternatives, created significantly more alternatives ($T = 6.04, p ≈ 0$).

6.3 Discussion

Study III shows that individuals generate more alternatives for a personally significant decision if they sequentially use each of their objectives to create alternatives. One explanation for this difference could be that there were differences between either/or the effort used or the creativity of the participants in the groups. However, examining the results in the first part indicated that participants of group 1 listed on average 5.48 alternatives and participants of group 2 listed 5.27 alternatives. The two-sided $t$-test reveals that this difference is not significant ($T = 0.68, p = 0.50$). Especially, since the individuals in group 1 created a similar number of alternatives in the first part and then more alternatives by generating alternatives using each objective separately, this result suggests that the use of each objective individually is better.

7. Study IV: Do Objectives Help to Create a Better Set of Alternatives?

In decision situations, whether one alternative or more than one alternative can be selected, prior to the selection of any alternative(s), not only the number and quality of the individual alternatives, but also the overall quality of the set of alternatives, is important to evaluate different processes of creating sets of alternatives. In the fourth study, we analyze the hypothesis that the quality of sets of alternatives generated using objectives is better than without using objectives.
7.1 Methods

7.1.1 Participants and Design. The study took place during an international summer program for multi-criteria decision making. Most of the 45 participants were PhD students or post docs coming from 25 different countries. There were 21 female and 24 male participants with an average age of 30.5 years. The study was conducted in English. The first part of this study, with four steps, was embedded in lectures on problem structuring and value-focused thinking and lasted on average approximately 40 minutes. The second part of the study took place two days later at the beginning of another lecture and lasted approximately 10 minutes.

7.1.2 Material and Procedure. Study IV was performed with paper and pencil. It dealt with what the participants could do to obtain an attractive academic position, a decision situation in which the participants were highly involved.

In the first part of this study, the participants were randomly divided into two groups, 22 participants in group 1 and 23 in group 2. Group 1 was stimulated by a master list of objectives, which had been created by the experimenters using a process similar to that described in Study II. The participants were not guided about how to use objectives; they were simply asked to list all alternatives that could help achieve their objectives. In contrast, group 2 created alternatives for the decision situation without being especially stimulated. In the second part of this study, conducted two days later, participants evaluated the relative overall quality of several randomly chosen pairs of sets of alternatives generated in the first part. In each comparison, one set of alternatives was created by an individual in group 1 and the other by an individual in group 2. The participants could not relate the sets of alternatives to the experimental condition in which they were created. Since there were \((23 \times 22 = 506)\) possible pairs of sets of alternatives and we wanted participants to carefully evaluate the relative quality of these pairs, each participant was only asked to compare approximately nine randomly generated pairs from the potential set.

7.2 Results

The participants of group 1, which has been stimulated with objectives, created between 5 and 19 alternatives with an average of 10.4 alternatives and a standard deviation 3.8. The participants of group 2 created between 3 and 14 alternatives with an average of 9.4 and a standard deviation 3.2. The difference between the numbers of alternatives generated by the groups is not significant. This lack of difference was desired, which was the reason why
the participants of group 1 received only a list of objectives presented without guidance how to use them to create alternatives. Hence, the subsequent comparison of the quality of the sets of alternatives generated by the two processes would be more insightful.

**Are the Sets of Alternatives Created With Objectives Better?** The participants collectively evaluated the relative quality of 415 distinct pairs of sets of alternatives. In 15 cases, participants did not clearly indicate their preference. Twice, a participant noted that he or she was indifferent or not able to compare both sets of alternatives. In the remaining 398 pairwise comparisons, the participants preferred the set of alternatives created with objectives 230 times and the set of alternatives created without objectives 168 times. If the sets of alternatives were equivalent in quality, the probability for choosing either set would be 0.5. The problem is describable by a binomial distribution. One obtains for \( p = q = 0.5 \), \( n_1 = 230 \) and \( n_2 = 168 \) that the sets of alternatives created with objectives are better on a significance level of 0.999.

7.3 Discussion

Study IV confirms that using objectives enhances the overall quality of a set of alternatives. One could say that this finding might mainly be due to the fact that the quality of a set of alternatives depends on the number of alternatives. Indeed, there is a strong correlation between the number of alternatives and the likelihood that the set of alternatives is preferred \( (r = 0.63, n = 45, T = 5.32, p = 0.000003) \). In Study IV, the group stimulated with objectives created one more alternative on average than the group not simulated with objectives. Therefore one may assume that stimulation causes the difference in the evaluation of the sets of alternatives. To examine this assumption the experimenters made the average number of alternatives of both groups approximately identical by taking out the sets of alternatives of the two participants in group 1 that used objectives who generated 18 and 19 alternatives, by far the most alternatives. These sets of alternatives were preferred in 29 comparisons and lower in only nine comparisons. With this scenario, the sets of alternatives created with objectives are still significantly better \( (p= q = 0.5, n_1 = 201, n_2 = 159, n = 360, P(X \leq k) = 0.988) \).


When facing an important policy or business decision, one usually has only one opportunity to solve or resolve it, rather than several tries to experiment to find out what might work well. Yet, the implications for creating alternatives derived from the above studies with large
groups of individuals facing personally relevant decisions may be useful for policy and business decisions. To preliminarily examine their relevance in such contexts, the following summarizes one policy application described in detail in Keeney (2012).

After the 2001 terrorist attacks on the World Trade Center, a National Institute of Standards and Technology (2005) report recommended that "Building evacuation should be improved to include system designs that facilitate safe and rapid egress, methods for ensuring clear and timely emergency communications to occupants, better occupant preparedness regarding their roles and duties for evacuation during emergencies, and incorporation of appropriate egress technologies."

In 2008, a 2.5-day invitation-only workshop was held to create alternatives that may improve evacuation of large buildings. The participants had experiences covering many relevant fields including firefighting, building codes, communications, construction, human behavior, and emergency management.

As all participants in the workshop had previously thought about building evacuation, each was initially asked to list any alternatives that he or she thought would enhance evacuation. This was partly to assure each participant that their previously developed ideas for alternatives would not be lost in the creative process to stimulate new thoughts for evacuation. After this, each participant was asked to create a list all of the objectives that were relevant to improve evacuation. Participants were subsequently given a page with general suggestions to stimulate the identification of additional objectives. Thirty-two participants provided lists of objectives. Collectively, there were 205 objectives on the initial list and 156 added with stimulation. During the evening of the first day, objectives listed by all individuals were combined and all remaining distinct objectives were organized into categories that were then structured in the means-ends objectives network shown in Figure 3.

On the beginning of the second workshop day, participants were presented their own objectives and the group’s collective objectives illustrated in Figure 3, and asked to create any not previously listed alternatives that would contribute to achieving any of the objectives individually. Then they were asked to create any additional alternatives by

As summarized in Keeney (2012), ‘Thirty participants generated alternatives on the first workshop day prior to listing objectives, 21 individually created additional alternatives on the second day after seeing the collective list of objectives, and 18 created alternatives based on pairs or combinations of objectives. The total number of alternatives created on the first
day of the workshop prior to explicitly thinking about objectives was 221. On the second
day, 81 more alternatives were created by considering single objectives, and 48 more
considering pairs and combinations. As the number of participants was smaller on the
second day, the averages were 7.4 alternatives prior to listing objectives and 3.8 and 2.7
additional alternatives for the two stages after viewing the collective set of objectives." For a
group of very knowledgeable professionals, who had created an average of 7.4 alternatives
on their own, to be able to create an additional average of 6.5 alternatives when stimulated
by objectives seems noteworthy.

**Figure 3: Means-Ends Objectives Network for Evacuation of Large Buildings.**

Later on the second day, groups of two to four individuals generated additional alternatives
that were different from those that the individuals in the respective groups already had
generated. In approximately an hour, this provided more than 50 additional alternatives.

During the second evening of the workshop the set of all alternatives identified in the
workshop were organized. Alternatives that were essentially duplicates were eliminated and
the remaining alternatives were categorized as shown in Table 5.

On the third morning, nine groups of 2 to 4 individuals each provided a preliminary appraisal
of the quality of 37 alternatives, selected to cover the range of the types of alternatives that
were generated. Quality was indicated in terms of three separate criteria: usefulness,
feasibility, and creativeness. Usefulness was defined as how well an alternative would
achieve the fundamental objectives of evacuation in Figure 3 and evaluated on a 1 to 9 scale, where 1 is poor and 9 is great. Feasibility was defined as the percent likelihood that the alternative could be effectively implemented within ten years. Creativeness was a subjective judgment on a 1 to 9 scale, where 1 is a standard well-known idea and 9 is an idea that you had not heard of before.

**Table 5**

On the third morning, nine groups of 2 to 4 individuals each provided a preliminary appraisal of the quality of 37 alternatives, selected to cover the range of the types of alternatives that were generated. Quality was indicated in terms of three separate criteria: usefulness, feasibility, and creativeness. Usefulness was defined as how well an alternative would achieve the fundamental objectives of evacuation in Figure 3 and evaluated on a 1 to 9 scale, where 1 is poor and 9 is great. Feasibility was defined as the percent likelihood that the alternative could be effectively implemented within ten years. Creativeness was a subjective judgment on a 1 to 9 scale, where 1 is a standard well-known idea and 9 is an idea that you had not heard of before.

**Table 5: Categories of Generated Alternatives from Keeney (2012).**

- Alternatives involving Sprinklers / Active Suppression Systems
- Alternatives involving Protect in Place / Areas of Refuge
- Alternatives involving Building Construction Changes
- Alternatives involving Building Material Changes
- Alternatives involving the Fire Service
- Alternatives involving Elevators
- Alternatives involving Societal /Regulatory / Legal Changes
- Alternatives External to the Building
- Alternatives involving Communication
- Alternatives involving Information Systems
- Alternatives involving Pre-event Planning
- Alternatives involving Efficient Use of Egress System
- Alternatives to Enhance Stairwell Evacuation / Reduce Stairwell Load
- Alternatives impacting the Design Process
- Alternatives that Enhance Reliability of Building Systems
- Alternatives that Involve Event Procedural Changes
- Alternatives that Enhance Event Detection
- Other Alternatives

It was interesting to note that essentially all of the evaluation groups appraised several alternatives at the top levels of each of the scales. Some alternatives were generally appraised very highly on all three of the criteria.
The workshop participants created more than 300 distinct alternatives. Each combination of these alternatives, of which there are literally millions, is itself a distinct alternative. The number of alternatives, taken together with the preliminary evaluations of the subset described above, suggests that the use of the objectives to stimulate the creation of alternatives for policy and business decisions has significant potential value.

9. Discussion

The results of our studies provided clear answers to the four questions that we posed in Section 1.

To what extent are decision makers able to identify alternatives for their own decisions?

The results of Studies I, II, and III clearly indicate that decision makers identify less than half of the alternatives useful to consider for their decisions. In Study I, participants identified alternatives corresponding to approximately 37% of the set of alternatives that each individual later recognized was relevant to their decision. In studies II and III, participants first listed alternatives for their respective decisions given little or no stimulation. Subsequently, they were asked to use objectives in various ways to stimulate the creation of alternatives. In the best cases, participants created about 127% as many additional alternatives as originally listed. If one accepts the 37% originally generated in Study I, this suggests that the participants identified at most 84% of their alternatives with the most effective stimulation with objectives. In Study II, all groups were informed that they had likely created less than half of their relevant alternatives and asked to create more alternatives. Four groups were stimulated with different sets of objectives, whereas participants of the control group were not provided any objectives. These participants created 80% as many additional alternatives as they originally created. If one again accepts that 37% of the possible alternatives are originally generated, when participants are provided more time and knowledge that there are many additional potentially available alternatives, participants recognized only about 67% of their alternatives.

How good are the alternatives that decision makers overlook?

Study I compared the alternatives initially identified by the participants with those that were overlooked and only recognized later from a master list. On average, these two sets of
identified and recognized alternatives were essentially equivalent in terms of three indicators of quality: the degree to which the alternatives would achieve the decision maker’s objectives, the effort to implement the alternatives, and the creativeness of the alternatives. Regarding the likelihood that the alternative would be implemented, only 44% of the participants identified their top-ranked alternative, only 10% of participants identified their three highest-ranked alternatives, and merely 1% identified all of their top-five alternatives. Obviously, one cannot generalize percentages from one or two studies as representing a definitive view on any situation. However, one may conclude preliminarily that, even after increasing the number of alternatives available to a decision maker by stimulation, a considerable number of alternatives still is not recognized and that these could be among the very best.

*Can the use of objectives to stimulate the creation of alternatives enhance the number and quality of alternatives?*

The results of studies II, III, and IV collectively suggest that the use of objectives can contribute to the creation of more and better alternatives. In Study III, participants were first asked to list all their alternatives prior to identifying any objectives they had for their decision. After identifying objectives, two groups of participants were asked to use their objectives differently to create additional alternatives. Prior to listing objectives, on average 5.4 alternatives were created and 3.7 and 5.7 additional alternatives were created for the two groups using objectives as stimulus. In Study II, four different groups each roughly doubled the number of created alternatives, relative to the initial number of generated alternatives, by using different sets of objectives. Study IV had two groups of participants create sets of alternatives with and without objectives as a stimulus. In 398 comparisons of pairs of randomly chosen sets of alternatives, where one set of alternatives was created without objectives to one set of alternatives was created with objectives, the participants selected the set of alternatives created with objectives as better in 230 of these cases, suggesting that better alternatives are created using the decision objectives.

*If objectives are useful to stimulate the creation of alternatives, how should they be used most effectively?*

Study II compared four different representations of the objectives for a specific decision to create alternatives. Most alternatives were created when the means-end network of objectives for the decision was presented to stimulate the creation of alternatives. In general, presenting all of the objectives resulted in more alternatives than presenting just
the fundamental objectives or an equal number of means objectives. Study III suggests that about 100% more alternatives are generated using a provided set of objectives if participants are told to use each objective individually to simulate thinking about potential alternatives. Without the guidance to use each objective individually, only 70% more alternatives are created.

9.1 Limitations and Interpretation

In the first step of Study II, one group first listed objectives and the other group-listed sources of information for a specific decision problem. Then, the two groups were asked to create alternatives. The group with sources of information created 6.71 alternatives on average, more than the 5.79 created on average by the group with objectives. This result is similar to that in a study of Selart and Johansen (2011), who found that presenting a set of objectives to meet by alternatives for a given decision led to creating fewer alternatives than not presenting the objectives. Accepting these results stresses the importance of providing guidance on how the decision maker should use objectives to create alternatives.

Logically, the number of alternatives that can be meet any set of more than one objective can be no greater than the number of alternatives that meet any single objective in the set. In general, unless the objectives in a set are redundant, one would expect more alternatives would meet any single objective than would meet all the objectives in the set. Thus, if explicitly or implicitly, decision makers feel that any suggested alternative should meet an entire set of objectives, fewer alternatives will be created than if decision makers were guided to create alternatives for the decision using each of the objectives individually.

Studies I and II reveal that there is a positive correlation between the time that individuals spend on the task of creating alternatives and the number of alternatives created. The cause and effect relationship may go both ways. It seems reasonable that if one spends more time thinking about possible alternatives, then he or she would likely create more alternatives. It also seems reasonable that when individuals think of more alternatives, it will take longer to conceptually characterize them and write them down. If a decision maker who created alternatives without using objectives is asked to use objectives to create more alternatives, this will encourage him or her to spend additional focused time on the task. In the second step of Study II, a control group was not given objectives to stimulate the creation of alternatives and just asked to create additional alternatives. This control group created fewer alternatives than any of the four groups stimulated with objectives. It would be
useful to have some focused research on the relationship between the time spend creating alternatives and the number and quality of alternatives created.

9.2 Implications for Decision Making

On decisions of importance where the creation of alternatives is deemed useful, decision makers want to spend their time as effectively as possible to create desirable alternatives. Accepting this, what practical advice might follow from the results of our research?

For such decisions, the decision maker usually would have some ideas of potential alternatives. Have them initially list all of these alternatives, which provides both an initial list of alternatives and clears one’s mind to facilitate creative thinking. Then, develop a full range of objectives for the decision, and structure them into a means-ends objectives network. Provide the objectives and the network to the decision makers and ask them to use each of the objectives one at a time to create additional alternatives. Finally use each of the alternatives on the list to help generate new and better alternatives by combining positive features of different alternatives into a new alternative and eliminating weak features of existing alternatives in the process. This procedure is akin to using a strategy table (Howard 1988) when all of the various features of an alternative have been clearly articulated.

A separate practical suggestion for certain decisions would be to create a master list of alternatives. This could be done effectively for any important decision that is faced by numerous individuals over time, but for which each individual faces it rarely. Decision such as those used in our studies, how to improve an internship, what internship to pursue, or how to enhance chances for an academic career, are ideal decisions where a master list of alternative would be helpful. This conclusion can be supported by the various requests of participants of these experiments to retain a copy of the master list after the experiment and the fact that the master list concerning the internship was very much of interest to the office of internships at the German university where Study I was conducted to help the next generation of students in organizing their internships. Similarly, a master list of alternatives to help an out-of-work professional get a good new job and get it sooner would potentially be helpful to many individuals.

Appendix. Statistical Tests Used in the Analysis
This appendix summarizes the statistical tests used in the analysis throughout this paper. The tests consider either a hypothesis that a stimulus has no effect – i.e. equal means – or that a stimulus increases or decreases the mean value. In two cases, a test on correlation is used. Generally, two groups, denoted by $i=1$ or $i=2$, are compared. The numerical values of all measurands used in this paper can either be expressed by positive integers or by a binary value-pair, e.g. “better” or “not better”. In the latter case, a binomial distribution is appropriate and significance tests are theoretically well defined as shown below. In the case of integer results, the underlying probability distribution generally is not known. Their expectation values $\mu_i$ and their standard deviations $\sigma_i$ are estimated by empirical mean values $\bar{x}_i$ and the empirical standard deviations $s_i$ that are calculated from $n_i$ measured data, respectively. The empirical correlation coefficient can be calculated from the measured $n$ data pairs. The two-sample $t$-test is used as a significance test. Testing for equal means requires the two-sided two-sample $t$-test and testing for increase or decrease requires the one-sided two-sample $t$-test. In all presented cases, the effective degree of freedom $\nu$ is significantly larger than 30, so using the so-called Welch-test is justified. The $T$-value is derived from empirical mean values $\bar{x}_i$ and empirical standard deviations $s_i$ and the numbers of the compared groups $n_i$. The computing routines used generate internally the effective degree of freedom $\nu$ and use it appropriately. In testing a hypothesis, the significance level $\alpha=0.05$ is used throughout this paper.

The hypothesis in the one-tailed test, $\mu_1>\mu_2$ or $\mu_1<\mu_2$, is rejected if $T > t_{1-\alpha,\nu}$ or if $T < t_{\alpha,\nu}$, respectively. Equivalently one can compute the probability $p$ for the occurrence of larger or smaller values than the measured $T$-value and reject the hypothesis if $p < 1-\alpha$ or $p < \alpha$, respectively. Since it provides better insight in the experimental results, the $T$-value and the probability $p$ for it are presented. For instance, consider a stimulus only given to group 1 and the hypothesis that this stimulus increases the numerical value of the measurand. This hypothesis would be rejected at a significance level of $\alpha=0.05$ if $T < t_{0.05,\nu}$ or equivalently if $p < 0.05$.

The hypothesis in the two-tailed test, $\mu_1=\mu_2$, is rejected if $|T| > t_{1-\alpha/2,\nu}$, where $\alpha=0.05$ is used and $\nu$ is the combined degree of freedom. For instance, consider a stimulus only given to group 1 and the hypothesis that this stimulus has no influence on the numerical value of the measurand. This hypothesis would be then rejected at a significance level of $\alpha=0.05$ if $T < t_{0.025,\nu}$ or $T < t_{0.975,\nu}$ equivalently if $p < 0.025$ or $p > 0.975$. 
The significance of a set of binary decisions is determined by using the binomial distribution. This is only used once in this paper. In this case, the total number was \( N=398 \) and \( n=230 \) favorable events had been observed. This allows estimating \( \hat{p} = 0.58 \) and \( \sigma_{\text{est}} = \sqrt{N\hat{p}(1-\hat{p})} = 9.85 \). One sees that the observed value \( 230 \approx 168 + 3\cdot \sigma_{\text{est}} \). This allows concluding that \( p \) is greater than 0.5 at a significance level of \( \alpha \approx 0.001 \).

Unless stated otherwise, the analysis of the significance of correlation coefficients is carried out with a one-sided \( t \)-test \( t_{n-2} = (r\sqrt{n-2})/\sqrt{1-r^2} \) with \( n \) representing the number of participants and \( r \) is the correlation coefficient. The correlation coefficient is given by

\[
r = \frac{\sum_{j=1}^{n}(x_{ij} - \bar{x}_i)(x_{ij} - \bar{x}_j)}{\sqrt{\sum_{j=1}^{n}(x_{ij} - \bar{x}_i)^2}\sum_{j=1}^{n}(x_{ij} - \bar{x}_j)^2}
\]

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