

Grouping Situations Based on their Psychological Characteristics Gives Insight into Personal Values

Ilir Kola¹ and Catholijn M. Jonker² and Myrthe L. Tielman³ and M. Birna van Riemsdijk⁴

Abstract. Support agents are investigated more and more as a way of assisting people in carrying out daily tasks. Support agents should be flexible in adapting their support to what their user needs. Research suggests that the situation someone is in affects their behaviour, however its effect has not been incorporated in the decision making of support agents. Modelling the characteristics of situations explicitly and studying their effect on internal perceptions of the user, such as their personal values, would enable support agents to provide more personalized support. We propose a method which groups situations according to their psychological characteristics, and in turn determines which personal values of the user would be promoted or demoted in each group of situations. To do this, we conduct a user study to gather data from participants about situations that they encounter in their daily lives. Results show that the created groups of situations significantly promote or demote certain personal values. This approach can allow support agents to help the user in a way which is in line with their personal values.

1 INTRODUCTION

Kurt Lewin, already 80 years ago, proposed that human behaviour is a function of both the personality of the person, as well as the situation in which they are in [18]. This is now a widely accepted idea in social psychology, after multiple debates in the field [24]. However, applications of support agents (e.g. [13, 20, 31]) focus mostly on modelling internal aspects of the user. Personal values are one of these aspects. They represent what is important to people [9], and because of that, they guide behavior. However, how important a certain value is for the user is not the only factor that guides behaviour. Whether that value is actually relevant in a given situation also plays an important role. For example, the fact that having an exciting life is important to someone plays a role in deciding the next holiday destination, but most probably does not affect the decision whether to have pizza or salad for dinner. On the other hand, the fact that someone values health would affect that decision, since having salad is supposed to promote the value health (i.e., help you fulfill it), whereas having pizza can demote it (i.e., prevent you from fulfilling it). This means that apart from personal values, it is important to also consider how the situation in which someone is in affects those values. This information can be used by a support agent in combination with information about the value preferences of the user in order to offer support on how to handle daily life situations. Continuing the

previous example, the agent would suggest having a salad to a user that finds health important.

In this work we will explore the relationship between the situation in which a user is in, and the personal values that are affected by the situation. To achieve this, first of all we explore ways how to group similar situations together. To do so, we will extend the work on Context Space Theory [21], which refers to a group of similar situations as a *subspace*. A situation subspace is a group of situations which have the same range of numerical values on certain attributes (Section 3.1). In this work, we use psychological characteristics of situations as attributes. Psychological characteristics are seen as dimensions that can be used to describe situations, similar to the manner in which people can be described with traits, attributes, or qualities [7]. Examples of these characteristics are positivity, duty, intellect, mating etc [24] (Section 3.2). This leads to the following research question:

- What methods can we use to group situations according to their psychological characteristics as context attributes?

Then, we investigate whether the identified subspaces significantly promote or demote personal values. Our research hypothesis is:

- Situations of the same subspace significantly promote or demote the same personal values, in comparison to a general population of situations.

While the research question and hypothesis guide the work presented in this paper, we do not aim to provide definitive answers here. Rather, as this is a novel research direction, our aim is to assess the feasibility of the approach as a basis for future work, as we proposed in previous work [15]. Our results indicate that it is possible to group situations into subspaces by using domain knowledge and insights from the data, and that situations from the same subspace tend to promote and demote the same personal values.

The rest of this paper is structured as follows: In Section 2 we present a high level architecture of our approach, and compare it to related work. In Section 3 we motivate our research choices for the use of psychological characteristics to group situations into subspaces, and we provide a short introduction to the concept of personal values. In Section 4 we present the user study in which we gather data in order to build the method which we described in the architecture. We present and discuss the results in Section 5, showing that situation subspaces can promote or demote specific personal values. Section 6 concludes this paper.

2 AGENT ARCHITECTURE

We propose an architecture which explains how a support agent can use information about the psychological characteristics of situations

¹ TU Delft, The Netherlands, email: i.kola@tudelft.nl

² TU Delft and Leiden Institute of Advanced Computer Science, The Netherlands, email: c.m.jonker@tudelft.nl

³ TU Delft, The Netherlands, email: m.l.tielman@tudelft.nl

⁴ University of Twente, The Netherlands, email: m.b.vanriemsdijk@utwente.nl

in order to determine the promoted or demoted personal values, and in turn offer support to the user. The architecture (Figure 1¹) depicts two main components: a learning component in which we use data gathered from people to identify situation subspaces, and a support agent which uses this information to provide support to the user.

In the first component, participants of a user study describe situations from their lives and provide us with the psychological characteristics as well as the promoted and demoted values of these situations (Section 4). We use these psychological characteristics together with domain knowledge in order to form situation subspaces (Section 5.2). Then, we determine the promoted or demoted values for each situation subspace (Section 5.3). When the support agent is interacting with the user, once presented with a new situation, the agent uses the subspace rules to classify the situation to a subspace, as done in Context Space Theory [21]. By knowing the subspace values, the agent can reason about the promoted or demoted values of that specific situation. This information, in combination with the value preferences of the user, can be used in order to reason about support. This last part is not tackled in this work, but is displayed in the architecture in order to make the bigger picture clear.

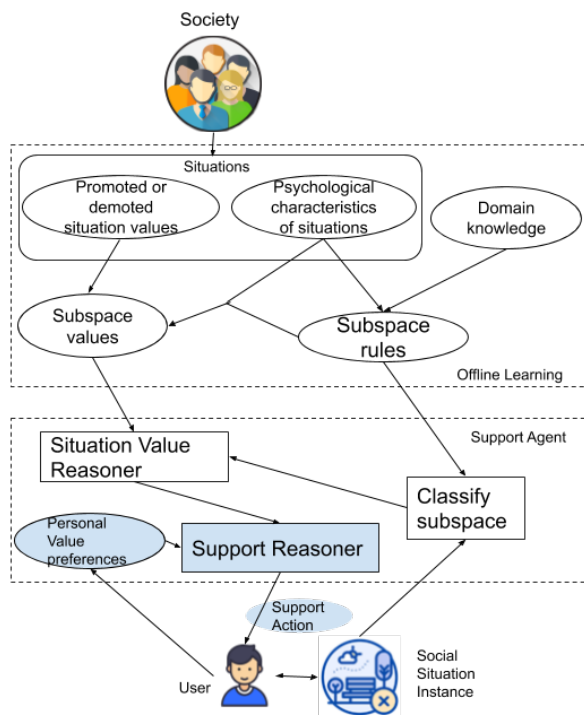


Figure 1. High-level architecture of the approach. Concepts shaded in blue represent aspects which we do not directly tackle in this work (i.e. Modeling the user preferences, extracting psychological characteristics of situations, and reasoning about the type of support). Circles represent knowledge elements (e.g. personal value scores, subspace rules), whereas squares represent reasoning steps. Arrows indicate the workflow of the approach.

This approach would allow support agents to align their suggestions with the personal values of their users. Let us consider an agent that recommends free time activities to the user, and the options are

¹ Icons used in the architecture were made by Freepik and retrieved from www.flaticon.com

going to a party and attending a workshop to learn a new skill. Following the architecture depicted in Figure 1, the agent might infer that the first would promote pleasure, and the second would promote capability. This way, the agent would suggest going to a party to a user who prefers the value pleasure, and attending the workshop to a user who prefers the value capability.

Related work Other work also focuses on using concepts such as personal values and context in socio-technical systems, in order to enable them to understand and adapt to human motivations. We introduce some of these approaches in order to position our work. Tielman et al [32] propose an approach to derive norms from a combination of values, context and actions. Context is used as a modifier to determine how much a value is promoted or demoted when performing a certain action, and this information is elicited from the user. Context is not modelled explicitly, and can be represented by a list of variables, depending on the situation. Similarly, Cranefield et al. [6] propose an approach on how to use values in order to help users with moral decisions. The work focuses on the reasoning about aligning the values of the user to the values that are promoted or demoted by different actions. Similarly, the values and context are assumed to be predetermined. Our work focuses on the other point of view: how to actually infer what values are promoted or demoted in a given situation? In a way, our work can be considered an extension of these approaches, since the output of our work can be used as an input for these reasoning frameworks. Kayal et al [13] also take a step in this direction. In their work, they ask participants about their personal values and about the promoted and demoted values of different social commitments. They then use this information to break ties when different commitments overlap. Our work aims at taking this a step further, since we present a procedure that automatically reasons about the promoted or demoted values of a situation, rather than always having to ask the user. Other work (e.g. [17, 14]) describes the relation between the environment and the people in terms of contextual affordances, which represent potential actions that the environment (or parts of it) allows people to perform. For instance, a chair allows the action “sit”. This is in principle similar to what we are doing, since personal values can be seen as affordances of a situation, since some situations allow people fulfill specific personal values. For example, a situation in which a person is exercising would help them fulfill the personal value of health.

3 SITUATIONS AND PERSONAL VALUES

3.1 Situation Subspaces

Research in computer science uses terms such as situation awareness (e.g. [8]) and context awareness (e.g. [1]) to describe attempts to enable artificial agents to better understand their surrounding environment. According to Barwise [3], these concepts refer to the same thing, and situations represent a way of modelling contexts. Other researchers (e.g. [2]) see context as a lower level of abstraction, and situations can be seen as “logically aggregated pieces of context”. In Endsley’s situation awareness framework [8], the aforementioned interpretation of context would refer to the situation cues in the perception level of situation awareness. There is vast research on modelling and reasoning about context and situations, and describing this research in depth is beyond the purview of this paper. For a detailed account, readers can refer to [4, 33]. In this section, we will introduce possible approaches on how to use context elements in order to determine the promoted and demoted values of a situation.

Our proposed approach is to first group similar situations into so-called situation subspaces, and then to determine the promoted and demoted values of that subspace. This is inspired by work on Context Space Theory [21]. In their approach, context is represented as an object in a multidimensional Euclidean space, called situation subspace. A context state is represented in terms of attributes, and each dimension of the situation subspace represents an accepted region for a specific context attribute. This way, when given a set of attributes that define a context state, we can infer whether the state is or is not part of the situation subspace. For example, a situation subspace can be “Person is healthy” and its attributes are “Body temperature” with an accepted region of values between 36.0 and 37.5 and “Resting heart rate” with an accepted region of values between 60 and 100. In our approach, we consider a situation subspace to be the set of situations having similar psychological characteristics (Section 3.2). For instance, a subspace can consist of situations where the characteristics Duty and Intellect have a value between 4 and 7.

Using situation subspaces facilitates the process of explaining the suggestions of the support agent to the user, since each subspace is defined by a set of attributes. The reasoning is explicit: for instance, situation X is in subspace A because of attributes B and C, and situations in subspace A promote values Y and Z. These steps can be available to the user. Furthermore, this way of approaching situations is also in line with work on social psychology on how people actually deal with situations. Gigerenzer [11] suggests that people have different modules of interaction, and when presented with a new situation they “classify” it as part of one of the modules, and then follow the “interaction script” of that module.

One other option for reasoning about the values of a situation would be to look at the correlation of each individual psychological characteristic of the situation with specific personal values (e.g. as done by [24]). However, this approach does not take into account the possibility that the ways in which characteristics are combined in a situation also affect the values that are promoted or demoted in it. We will explore this possible connection in Section 5.3. In the current section we will simply give an intuition. For instance, situations with a high level of mating can in general affect the value pleasure, however it is the combination with high positivity or high negativity that affects whether the value is promoted or demoted. Furthermore, if we consider each psychological characteristic individually, it is not clear whether the low score of a characteristic indicates that a value is demoted or not affected. For instance, knowing that situations with high intellect promote capability is not enough to determine whether situations with low intellect demote this value or do not affect it. Our approach takes the potential effect that the combination of psychological characteristics have on personal values into account, but does not rely on it: if that effect does not hold, our approach would simply take into account the correlation between individual psychological characteristics and personal values.

Lastly, we can reason about personal values by training a model that takes as input the situation’s psychological characteristics, and predicts the score for each value. This way, the model would actually take into account all the psychological characteristics of the situation and their potential interactions. Putting aside the requirement for high amounts of data and the non-trivial task of building such a model, our primary reason for not following this approach is its black box nature. We believe one of the key features of a support agent is its ability to explain its suggestions to the user. Such a comparison, and the potential trade-off between accuracy and explainability, is something that we plan to explore in future work.

3.2 Psychological Characteristics of Situations

Research in social psychology has explored ways in which situations can be systematically described. Rauthmann et al. [24] discuss three ways in which situational information can be taxonomized: Cues (e.g. persons, places, objects etc.); (psychological) Characteristics (which attributes can be used to describe situations - e.g. positivity, intellect, duty etc.); Classes (which kind of situations are there - e.g. social situations, work situations etc.).

In this work we focus on the use of psychological characteristics. There are several taxonomies of situations on the psychological characteristics level. We choose the DIAMONDS taxonomy since it covers a wide variety of daily life activities and it provides a validated 24-items survey which allows the measurement of the psychological characteristics of situations through online surveys. Horstmann et al [12] suggest that the dimensions of the existing taxonomies have a high level of similarity when compared across taxonomies, so our choice should not influence the outcome of the work. The DIAMONDS taxonomy describes situations in terms of the following dimensions:

- **Duty** - situations where a job has to be done, minor details are important, and rational thinking is called for;
- **Intellect** - situations that afford an opportunity to demonstrate intellectual capacity;
- **Adversity** - situations where you or someone else are (potentially) being criticized, blamed, or under threat;
- **Mating** - situations where potential romantic partners are present, and physical attractiveness is relevant;
- **Positivity** - playful and enjoyable situations, which are simple and clear-cut;
- **Negativity** - stressful, frustrating, and anxiety-inducing situations;
- **Deception** - situations where someone might be deceitful. These situations may cause feelings of hostility;
- **Sociality** - situations where social interaction is possible, and close personal relationships are present or have the potential to develop.

There are different reasons for using the psychological characteristics of situations in order to group them. First of all, psychological characteristics allow us to assess similarities between situations beyond their physical cues (e.g. where is the situation taking place, how many people are involved). Social psychology (e.g. [5, 7, 23, 30]) suggests that people think about situations by using their psychological characteristics. They create impressions of situations as if they were real, coherent entities. These impressions allow people to better navigate through the world by being able to predict what will happen and coordinate behaviour accordingly. This inherent psychological component of situations makes them difficult to interpret only in terms of physical context. For instance, let us consider a scenario where our user, Alice, is going out with friends. The relevant physical attributes would be the activity (i.e. going out), the location, time etc. A support agent might determine that such situation promotes pleasure. On the other hand, it is also possible that at some point Alice is going out and some people that she dislikes join. In that case, the situation could actually demote the value pleasure. However, from the point of view of physical cues, everything would remain the same and this difference would not be captured. Kola et al. [16] propose a set of social cues that can be used to capture such differences, for example the quality of the relationship with the other person or the level of trust. However, despite capturing the psychological component of situations, these social cues remain a low-level description.

Another advantage of focusing on the psychological characteristics is easiness of explainability. This means the support agent can explain its suggestions to the user in a way that is understandable and intuitive to people. To continue the previous scenario, we assume our support agent wants to propose an activity which promotes the value of pleasure to Alice, since this value is important to her. It would be more intuitive for Alice to understand that the situation “going out with friends” promotes pleasure because it has high positivity and low adversity, rather than because it is an activity that takes place after 8pm, at a bar, and a certain amount of people are present.

Focusing on the psychological characteristics of situations allows us to identify similarities in situations that look very different. For instance, a situation in which a parent is helping their child with a school project and a situation in which that same parent has an important work meeting do not have anything in common when it comes to physical cues, however they both potentially involve a high level of duty and intellect, and promote values such as helpfulness and capability. This also brings forward practical considerations from a technical point of view: there can be a very high number of physical cues that can be measured, and what is actually relevant differs from situation to situation. Furthermore, highly general concepts such as “activity” are difficult to model in a way which actually makes them comparable from a situation to another. For these reasons, deciding which elements to model and how to do it is both crucial and non-trivial. Our approach allows us to abstract from the physical context, which results in a low dimensionality of characteristics that are proven to be relevant across daily situations [24].

There is some difference in terminology when comparing Context Space Theory with DIAMONDS. A context state from Context State Theory is simply referred to as a situation in DIAMONDS, and context attributes would be represented by the situation dimensions. In this work, we will use the DIAMONDS terminology.

3.3 Personal Values

Values represent key drivers of human decision making (e.g. [26, 27]). Friedman and colleagues [9] define values as “what a person or group of people consider important in life”. People hold various values (e.g. wealth, health, independence) with different degrees of importance. The main features of personal values which make them relevant to our work have been explicitly described by Schwartz [29], but are also implicitly present in other work on values. First of all, values refer to desirable goals that motivate action, and they serve as standards to guide the selection of actions, people, or events. This means that (unconsciously) people’s decisions are influenced by values. Secondly, values transcend specific actions and situations. For instance, values such as honesty are important to someone regardless of the activity they are doing or who they are with. Lastly, what puts this all together is the fact that in order for values to influence action not only should they be important to the actor, but they should also be relevant in that specific context. This suggests that if we know which values are likely to be activated in a certain context (or situation) and have information about the value preferences of a user, we can use that information to evaluate how much does a situation promote or demote personal values that are important to the user. It is also important to notice that in this work, we talk about personal values on three different levels:

- Personal values are important to an individual - e.g. Alice values achievement;
- A specific situation can promote or demote personal values to

someone in the situation - e.g. Being a speaker at a conference promotes the value achievement for Alice;

- A situation from a certain subspace usually enables promoting or demoting a personal value to someone in the situation - e.g. Being part of situations with high intellect and high duty usually promotes the value achievement for people.

The most prominent models of human values were proposed by Rokeach [26] and Schwartz [27]. These models are universal and domain-independent, making them suitable for our purpose, in which we will deal with a wide range of every day situations. This is different from other approaches where the first step was to find a subset of values which are more applicable to a certain domain, for instance mobile location sharing [13] or music recommendations [19]. In our work we use the model proposed by Schwartz since it offers validated measurement instruments with fewer items than Rokeach, which makes them more applicable to online surveys. Furthermore, it is to be noted that Schwartz builds on the work of Rokeach and other researchers, so there is overlap in their proposed value lists. The Schwartz theory of basic human values [27] recognizes 10 universal value groups, namely: Self-direction, Stimulation, Hedonism, Achievement, Power, Security, Conformity, Tradition, Benevolence and Universalism. Each of these value groups includes more “specific” values, as depicted in Table 2.

4 USER STUDY

In this user study we gather data² for constructing and evaluating our methods. The study consists of three parts: first, participants were asked to describe situations from their daily lives (part 1), then they had to answer questions about the psychological characteristics of the situations (part 2) and finally they had to answer questions about how much the situations promote or demote certain personal values (part 3). The study was approved by the ethics committee of TU Delft.

Participants We collected answers from 150 participants recruited in the crowd-sourcing platform Prolific Academic³. Using a crowd-sourcing platform allowed us to efficiently obtain a large sample size in a short amount of time. Respondents received a monetary compensation for the time they spent, as per the platform policies. The average age of participants was 32.38 (SD=12.1). 51.3% were female, 44% male, and 4.7% selected the option “other” when asked about their gender.

Procedure ⁴ In order to have enough data to evaluate whether clustering situations is useful, it is important that we use a method that generates a diverse sample of situations. To this end, we use a method applied in other research that asks participants to describe a situation in their daily lives (e.g. [10, 25]). This retrospective procedure was shown to encourage participants to report on a wide range of situations. We asked participants to think about two situations which occurred during the past weeks which involved one other person, since our focus is on social situations. We specifically asked for situations involving only one other person, since if needed it is possible to control the effect of the relationship with the other person on the situation. However, the approach would work the same way for situations involving multiple other people. We instructed participants to think

² The data can be accessed under: <https://doi.org/10.4121/12867041>

³ <https://www.prolific.co/>

⁴ The survey questions can be found in Appendix A

of situations where a concrete activity took place, and not situations such as “I saw someone in the street and said hello”. A positive example was not given in order to avoid priming the participants towards certain situation types. Participants were asked to describe the situations in 3-4 sentences and to focus on describing the activity, their relation to the other person, as well as how each person behaved in the situation. Furthermore, we instructed participants to try to think of diverse situations, which involved different people and where different activities took place. To check for consistency, participants had to answer four open questions about the situation they just described: when did the situation take place, what was the main activity, where did the situation occur, and what is the role of the other person.

In the second part of the study, participants were presented with a set of statements to measure psychological characteristics of situations, and they were asked how much each statement applies to each of the situations that they had just described. Examples of statements were “A job needs to be done”, “Task-oriented thinking is required” etc. The statements were taken from the S8* scale proposed by Rauthmann and Sherman [25]. This is a validated instrument which can be used to measure the DIAMONDS dimensions of a situation. Each dimension is represented by three statements, for an overall total of 24 statements. Participants could indicate their answers on a scale ranging from 1 (not at all) to 7 (totally).

In the last part, participants were presented with a list of personal values, and they were asked on a slider with values from -10 (fully demote) to 10 (fully promote), how much is each value promoted or demoted in each of their two situation. Participants were presented with 21 personal values, which are based on a version of the Schwartz Value Survey [27] which was used on the European Social Survey [28]. Each of the universal value groups is represented by two values, apart from Universalism which is represented by three. In the original survey, each item of the list describes a feature that a person might exhibit (e.g. “She seeks every chance she can to have fun. It is important to her to do things that give her pleasure.”), which correspond to a personal value (e.g. “pleasure”). This was done because the aim of the European Social Survey was to explore personal values that people find important, and for that purpose framing values as features of a person was useful. In this study, we want to know how much a value is promoted or demoted in a certain situation, therefore framing values as qualities of a person would not work. For this reason, we presented participants with the underlying value of each item on the list. The only change that was made to the list was to replace the value “National security” with the value “Health”, which is also a value from the Security value group. The reason for this is that we believe it is common for people to commonly encounter situations that can affect their health (e.g. sports, choice of food), but we do not expect them to encounter situations that affect national security.

5 RESULTS AND DISCUSSION

5.1 Variety of Situations

Participants reported situations involving a wide range of other people, including a friend (24%), a family member (20%), a co-worker or supervisor (17%), a romantic partner (12%), an acquaintance (3%) or other (24%, mostly consisting of strangers). These situations comprised a high variety of activities, ranging from work meetings to dinner dates, from sport activities to discussions with other drivers, and everything in between. This is also shown by the high variety of the ratings that participants gave to the psychological characteristics of these situations. The rating for each dimension was calculated as the

average score that the participant gave to the three statements representing that dimension, following the guidelines of the S8* measurement scale that we are adopting [25]. As seen in Figure 2, most of the dimensions have ratings across the whole range of possible alternatives, apart from Adversity and Mating which tend to have a more confined distribution and less variety in general. The score for each dimension is calculated as the average score across the three statements of the questionnaire that define that dimension. We provide a detailed distribution of answers for each psychological characteristic in Figure 2, since this insight will be used to form the subspaces in Section 5.2.

When it comes to personal values that are afforded in these situations according to the participants, the scores also have high variety, as depicted in the distribution presented in Figure 3. This distribution suggests that that values were differently promoted or demoted across situations. However, it also holds that most values were slightly promoted on average (overall mean=1.24, SD=4.68). This is in line with research on personal values [26] which views them as positive concepts.

5.2 Forming Situation Subspaces

In this subsection, we will group situations according to their psychological characteristics into situation subspaces. We will try an automatic approach, as well as one based on domain knowledge and insights from the data.

5.2.1 Automatic Clustering

The most straightforward way to form the situation subspaces is by using a clustering algorithm. We tried state of the art algorithms such as K-Means, Affinity Propagation and Agglomerative Clustering using different parameters. The algorithm would receive as an input the psychological characteristics scores of each situation, and return the cluster to which that situation should belong. We evaluated them with standard metrics used in cases where there is no ground truth when it comes to cluster memberships, such as the Silhouette coefficient and the Davies-Bouldin Index. We used the implementations from the scikit-learn package [22] in Python. The best configuration was achieved by the K-Means algorithm with two clusters, which achieved a Silhouette score of 2.4, and a Davies-Bouldin index of 1.59. These metrics suggest that the data is not well separable when we use all the dimensions in order to perform the clustering. This was to some extent to be expected, considering the high variety of situations, and the fact that there are 8 dimensions and only 300 situations in total. In future work we will collect more situations and explore whether that leads to a higher number of similar situations in the dataset, which could potentially lead to better defined clusters.

While exploring the scores of the dimensions in these two clusters, we notice that in the first cluster Positivity and Mating have a higher score than the average and the other six dimensions have a lower score. In the second cluster this trend is inverted. However, we also notice that each cluster contains situations with scores across the full range of scores for each of the dimensions. First of all, this suggests that these clusters are difficult to interpret/explain since they do not have clear distinguishing features. Secondly, in order to be able to use the Context Space Theory framework, attributes need to have a defined range, which means for at least some of the dimensions we need to have a cutting threshold. This is not the case for the formed clusters, and when faced with a new situation, it is not trivial

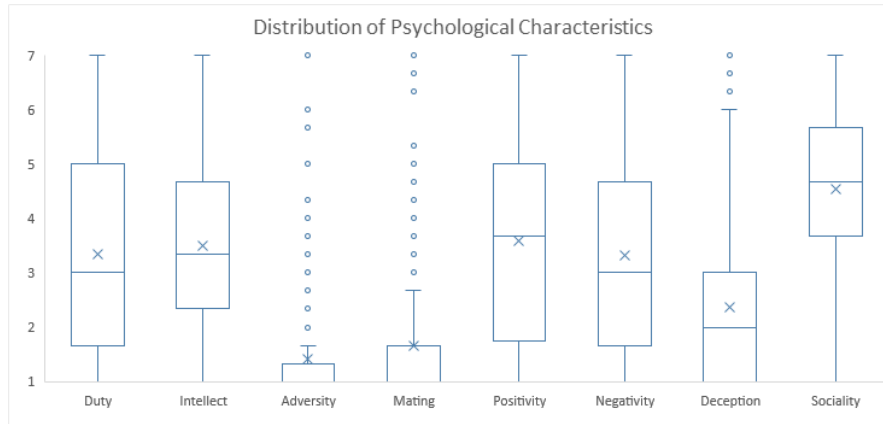


Figure 2. Distribution of scores across situations for each dimension, expressing the variety of situations from a point of view of their psychological characteristics. For each boxplot, the middle line represents the median, the sides of the boxes represent the first and third quartiles, and the whiskers represent the minimum and maximum values without considering outliers (which are represented by round points). The x represents the mean scores of the dimensions.

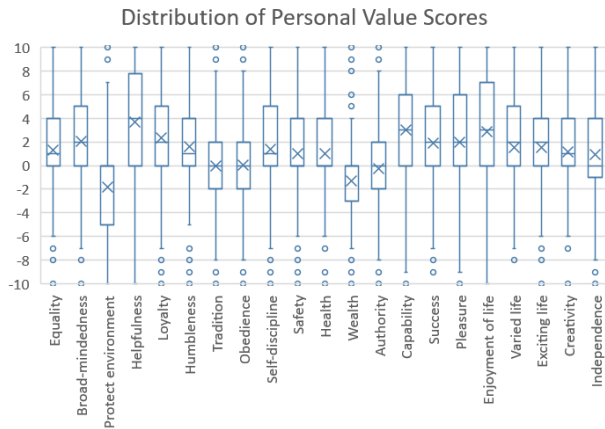


Figure 3. Distribution of scores for each personal value across situations.

to determine to which cluster it belongs. Overall, we notice that performing automatic clustering on our data leads to clusters consisting of situations which share some similarity in terms of psychological characteristics, but the division is not granular enough.

5.2.2 Using Data Insight and Domain Knowledge

The next approach will be to use insights from the data as well as domain knowledge in order to manually group situations into situation subspaces. It is important to notice that by “data insights” we only refer to the scores given to the situation dimensions, and not the scores assigned to personal values. From the previous subsection, we learn that trying to cluster over all dimensions is not effective because of the low amount of data and its high variety. For this reason, we use less dimensions in order to define each situation subspace. In order to identify these dimensions, first of all we explore the data. In Figure 2 we notice that the dimensions which bring the highest variety to the data are positivity, negativity, intellect and duty. This makes combinations of these dimensions suitable for defining the situation subspaces, since their scores have a high range, and the combinations would lead to subspaces with similar numbers of situations in them. Another insight from the data is that adversity has a very low variety,

which makes the situations with a high adversity to form a particular group when compared to the rest. The same applies to mating, but adversity serves the purpose more since it contains outliers. Domain knowledge about the nature of these dimensions can also inform the process of selecting dimensions used to define subspaces. Positivity and negativity, despite being independent concepts, have an inherently opposite flavor. On the other hand, negativity has similar connotations with deception. This is also confirmed by the Pearson correlation coefficients between the data (positivity-negativity: -0.56, negativity-deception: 0.37). This information was used to define six situation subspaces:

- Subspace 1 - High Duty, High Intellect, Low Adversity;
- Subspace 2 - High Positivity, Low Duty, Low Intellect;
- Subspace 3 - High Duty, Low Intellect;
- Subspace 4 - High Adversity;
- Subspace 5 - High Negativity, Low Positivity, Low Duty, Low Intellect, Low Adversity;
- Subspace 6 - High Intellect, Low Duty.

The description “High” refers to scores between 4-7, while the description “Low” refers to scores between 1-3.99 (non-integer scores are possible since each dimension is calculated as the mean of three items from the survey). That means the dimension is highly or lowly characteristic of situations in that subspace. These subspaces allow us to classify 262 out of the 300 situations in our data set. When exploring the remaining situations, we notice that all dimensions other than sociality have a low score. For this reason, we use sociality as a dimension to define the final split, thus forming the last two subspaces:

- Subspace 7 - Low Sociality, and all other dimensions also Low;
- Subspace 8 - High Sociality, and all other dimensions Low.

These subspaces are designed to work well with the Context Space Theory framework, since each of them is defined by a set of attributes with specific values. This allows for a straightforward way for classifying a new situation to a subspace. Figure 4 provides a visualisation of this, by depicting four of the subspaces projected onto their defining dimensions, for illustration purposes. These defining dimensions enable the subspaces to be more interpretable and explainable in terms of the psychological characteristics that apply to their situations, when compared to the automatic clusters that were created.

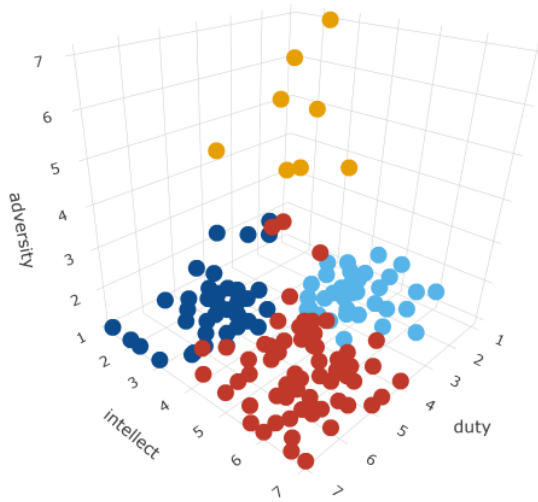


Figure 4. Visualisation of four situation subspaces defined by Adversity, Intellect and Duty. Red dots represent situations from Subsp. 1, dark blue dots represent situations from Subs. 3, orange dots represent situations from Subsp. 4, and light blue dots represent situations from Subsp. 6.

We notice that the subspaces are not strictly disjoint. However, this is not a restriction from Context Space Theory, where our approach is based. This also works on an intuitive level, since situations are fluid concepts which can be “in between” two different subspaces. In future work, we will work on strategies on how to break possible ties. Padovitz et al. [21] propose using optional attributes which would increase the probability of a situation being in a subspace.

Using intrinsic metrics for evaluating clusters like we did for the automatic clusters (Silhouette score, Davis-Bouldin Index) would heavily penalize the manual subspaces, since these scores apply to all eight dimensions, whereas the subspaces were defined on a smaller subset of dimensions. For example, in Figure 4 we see that the subspaces would be well separated if we only consider the dimensions on which they were defined. In future work it will be important to define evaluation metrics for manually created subspaces.

We notice a high diversity of activities taking place in the situations of each subspace. For example, Subspace 1 (defined by high duty, high intellect and low adversity), comprises, apart from work situations, also activities such as going to a suture course with a friend, or discussing the family finances with the partner. Similarly, Subspace 4 (defined by high adversity) includes situations ranging from someone being accused of cheating in a card game, to someone being lectured from the CEO of the company. This supports our initial premise that analysing the psychological characteristics of situations can point out to similarities between situations that seem very different at first sight. A similar variety is also present when it comes to the role of the other person in the situation. In our setup, roles are mutually exclusive. The distributions are depicted in Table 1. As we can see, in each subspace there are people from almost all the roles present. As expected, Subspace 1 (situations with high intellect and duty) include more colleagues, and Subspace 2 (situations with high positivity, low duty and low intellect) include more family and friends, and less colleagues. This aspect will be analysed further in future work.

	Fam	Rom	Fr	Coll	Gr	Other
Subspace 1 (n=74)	12.5	9.72	16.67	37.5	4.17	19.44
Subspace 2 (n=77)	23.08	14.1	34.62	8.97	1.28	17.95
Subspace 3 (n=44)	20.45	9.09	20.45	11.36	4.55	34.09
Subspace 4 (n=10)	12.5	0	12.5	25	25	25
Subspace 5 (n=19)	45	15	15	5	5	15
Subspace 6 (n=40)	12.5	12.5	35	15	0	25
Subspace 7 (n=24)	18.52	18.52	11.11	7.41	3.7	40.74
Subspace 8 (n=12)	36.36	9.09	27.27	9.09	0	18.18
All situations (n=300)	20	12	24	17	3.33	23.67

Table 1. Distribution of the other person’s roles in the situations of each subspace (in percentage). n represents the number of situations (and therefore, the number of people, since situations involve the user and one other person) in each subspace. Fam = Family Member, Rom = Romantic Partner, Fr = Friend, Coll = Colleague, Gr = Group Member

5.3 Promoted and Demoted Personal Values

In this section, we explore whether specific values tend to be more promoted or demoted across situation subspaces. We look at this from two points of view. First of all, we take into consideration statistical significance. For this, we perform the Wilcoxon rank-sum test to check whether the scores of each value in the situations of a subspace are significantly different from the ones in the rest of situations. Secondly, we look at the mean scores. We consider that a subspace strongly promotes a value when the mean score of the values in its situations is higher than 3.5, and it strongly demotes a value when the mean score is lower than -2.5. Demoting has a lower threshold since we notice that participants tend to give slightly more positive scores overall (the overall mean is 1.24). Despite the distributions not being strictly normal, we believe the mean can be informative since the scale is limited between -10 and 10 so there are no values that can greatly skew it. We also calculated the median, and there is a very high overlap in the values that fulfill the criteria (22 out of 26). We do not report the medians for space purposes. We perform this analysis for the automatically created clusters, as well as for our manually formed subspaces.

When it comes to the automatically created clusters, we notice that the first one significantly promotes the values pleasure (3.87) and enjoyment of life (4.87), whereas the second cluster significantly promotes the value capability (4.08). No values are significantly demoted in either cluster. We do not report all values for space purposes. When comparing these results to the interpretation of the clusters using the psychological characteristics of situations, it seems intuitive that the cluster with higher positivity and mating promotes pleasure and enjoyment of life, whereas the cluster with higher duty and intellect promotes capability. The divisions are not granular enough to help us determine a larger number of promoted and demoted values, since we have only two clusters which consist of diverse situations. However, this analysis hints towards the idea that subsets of the data which share similar psychological characteristics do tend to promote certain values more than others, when compared to the overall data.

Next, we perform the same analysis for our manually crafted situation subspaces (Table 2). We notice that 5 of the subspaces significantly promote or demote some personal values, thus supporting our initial hypothesis. By analysing these results further, we notice that they are also aligned with the common sense understanding of these concepts: values such as pleasure and enjoyment of life are promoted in situations defined by high positivity (Subspace 2) and demoted in situations defined by high adversity (Subspace 4). Moreover, situations defined by high intellect and duty promote values such as help-

Table 2. Average score for each value in each cluster as well as the full data set. Scores in bold mean that the value is promoted or demoted in that cluster, with boundaries at <-2.5 for demoting and >3.5 for promoting. Scores marked with * suggest statistical significance with $p<0.05$ when performing the unpaired Wilcoxon rank-sum test for the cluster vs. the rest of the data.

Value (value group)	Subsp 1	Subsp 2	Subs 3	Subs 4	Subsp 5	Subsp 6	Subsp 7	Subsp 8	All Situations
Equality (Universalism)	2.2	1.72	1.11	-1.5*	-2.63*	2.03	0.96	1.82	1.32
Broad-mindedness (Universalism)	3.5*	1.74	1.07*	-0.5*	1	3.98*	-0.37*	1.36	2.07
Protect environment (Universalism)	-2.04	-2.7	-0.95	-1.88	-2.37	-1.25	-0.52	-1.36	-1.79
Helpfulness (Benevolence)	5.58*	2.5*	4.41	-1.5*	0.63*	3.48	2.89	6.18	3.66
Loyalty (Benevolence)	3.07	3.26	1.8	-2.38*	0.37*	2.78	0.33*	3.45	2.33
Humbleness (Tradition)	2.47	2.05	1.34	-0.75*	-0.63	1.68	1.07	1.09	1.64
Tradition (Tradition)	0.45	-0.09	0.25	-0.88	-3.05*	0.85	-0.93	1.45	-0.04
Obedience (Conformity)	1.49*	-0.79	0.52	-2.63	2	-1.15	-1.11	0.55	0.05
Self-discipline (Conformity)	3.68*	-1.18*	2.82*	1.5	1.68	1.18	1.33	1	1.39
Safety (Security)	1.95	-0.21*	2.3	-3.88*	0.11	1.4	0.78	2.36	1.02
Health (Security)	1.18	0.2*	1.89	-1	-0.32	1.8	1.33	3.91	1.01
Wealth (Power)	-0.89	-1.55	-1.32	-0.88	-1.26	-1.48	-1.63	-0.09	-1.28
Authority (Power)	1.27*	-1.86*	1.34*	-1	-1.47	-0.48	-1.3	1	-0.24
Capability (Achievement)	5.45*	1.78*	3.86	1	0.74*	3.15	1.11*	2.09	2.99
Success (Achievement)	4.04*	1.29	2.55	0.63	-1.63*	1.83	1.19	0.82	1.93
Pleasure (Hedonism)	1.15	5.76*	-0.77*	-3.5*	-3.63*	4.55*	0.3	0.18	1.94
Enjoyment of life (Hedonism)	1.93	6.82*	0.02*	-3.25*	-0.63*	4.73*	1.15*	2.45	2.9
A varied life (Stimulation)	1.7	2.62*	1.5	-0.63	-0.05	2.33	-1.04*	1.82	1.56
An exciting life (Stimulation)	0.85	4.01*	0*	-1.38*	-0.05	2.58	-0.26*	-0.18*	1.5
Creativity (Self-direction)	2.68*	1.54	0.39	-1.13	-2.74*	2.15	-0.96	1.64	1.18
Independence (Self-direction)	2.39*	0.33	1.39	-0.88	-1.53	0.65	0.37	1.64	0.91

fulness, capability and success. These intuitive connections suggest that a support agent that uses this method would have the possibility to explain its suggestions to the users in an understandable way. Furthermore, it seems like the promoted or demoted values are affected by the combination of dimensions, rather than by each dimension individually. For instance, situations defined by both high intellect and duty (Subspace 1) significantly promote success and helpfulness, whereas situations defined by high duty and low intellect (Subspace 3) or low duty and high intellect (Subspace 6) do not promote these values.

6 CONCLUSION

6.1 Contributions

In this work we present an approach in which we group situations into subspaces by using their psychological characteristics as attributes, and show that these subspaces can be used to determine which personal values are promoted or demoted in these situations. In order to explore our research question, we use automatic clustering, as well as insights from the data combined with domain knowledge, in order to group situations according to their psychological characteristics. We notice that automatic methods lead to clusters which are not well defined, while the manual method allowed us to form groups that fit the requirements of Context Space Theory.

Secondly, we show that certain personal values are significantly more promoted or demoted in specific situation subspaces, thus confirming our research hypothesis. This can be used as a method to automatically determine how the situation that a user faces affects the personal values of the user. This would be a useful extension for current support agents [6, 32] that rely only on information from the users to know the effect it has on personal values.

An advantage of this approach is its potential for providing explainable support to the user. Our methods are inherently more explainable than black box approaches, and we borrow the attributes

that form the basis of our approach from social psychology. Concepts such as the psychological characteristics or personal values are potentially more understandable for users.

6.2 Limitations and Future Work

Considering that the work is still in its early stage, there are limitations which we aim to tackle in the future. First of all, we assume that we already know the psychological characteristics of a situation. This is not a trivial task, and in order to have a supportive agent that can help in real life cases, these characteristics will have to be inferred from situation cues. Work from Kola et al. [16] provides initial evidence that they can be used to infer concepts such as the priority of situations. In the future, we will explore whether that approach can be applied to the psychological characteristics of situations.

Secondly, we detect more affected values in the manually defined situation subspaces. While this approach is not necessarily weaker than an automatic approach, it has to be tested with a wider range of situations. The reason for this is that it was crafted particularly for this set of situations, so its effectiveness for another set of situations is to be determined. In the future, we will work on having a well-defined formal procedure on how to form situation subspaces by using the psychological characteristics of situations as context attributes. Another option will be to explore forming automatic clusters by considering a subset of the dimensions.

Next, the promoted and demoted values need to be analysed further. We notice three of the subspaces do not promote or demote any personal values, and some personal values are neither promoted nor demoted in any subspace. In future work, we will explore using a more specific list of values which are salient to daily life situations. Lastly, we will explore whether situation subspaces can help determine concepts other than personal values, such as expected behaviour.

ACKNOWLEDGEMENTS

This work is part of the research programme CoreSAEP, with project number 639.022.416, which is financed by the Netherlands Organisation for Scientific Research (NWO).

REFERENCES

- [1] Varol Akman and Mehmet Surav, ‘Steps toward formalizing context’, *AI magazine*, **17**(3), 55, (1996).
- [2] Christos B Anagnostopoulos, Yiorgos Ntirladimas, and Stathes Hadjiefthymiades, ‘Situational computing: An innovative architecture with imprecise reasoning’, *Journal of Systems and Software*, **80**(12), 1993–2014, (2007).
- [3] Jon Barwise, ‘Situations and Small Worlds’, *Handbook of Semantics*, (1987).
- [4] Claudio Bettini, Oliver Brdiczka, Karen Henriksen, Jadwiga Indulska, Daniela Nicklas, Anand Ranganathan, and Daniele Riboni, ‘A survey of context modelling and reasoning techniques’, *Pervasive and Mobile Computing*, **6**(2), 161–180, (2010).
- [5] Nancy Cantor, Walter Mischel, and Judith C Schwartz, ‘A prototype analysis of psychological situations’, *Cognitive psychology*, **14**(1), 45–77, (1982).
- [6] Stephen Cranefield, Michael Winikoff, Virginia Dignum, and Frank Dignum, ‘No pizza for you: Value-based plan selection in bdi agents.’, in *IJCAI*, pp. 178–184, (2017).
- [7] John A Edwards and Angela Templeton, ‘The structure of perceived qualities of situations’, *European journal of social psychology*, **35**(6), 705–723, (2005).
- [8] Mica R Endsley, ‘Toward a theory of situation awareness in dynamic systems’, *Human Factors*, **37**(1), 32–64, (1995).
- [9] Batya Friedman, Peter H Kahn, and Alan Borning, ‘Value sensitive design and information systems’, *The handbook of information and computer ethics*, 69–101, (2008).
- [10] Fabiola H Gerpott, Daniel Balliet, Simon Columbus, Catherine Molho, and Reinout E de Vries, ‘How do people think about interdependence? a multidimensional model of subjective outcome interdependence.’, *Journal of Personality and Social Psychology*, **115**(4), 716, (2018).
- [11] Gerd Gigerenzer, ‘10 the modularity of social intelligence’, *Machiavellian intelligence II: Extensions and evaluations*, **2**(264), 264–288, (1997).
- [12] Kai T Horstmann, John F Rauthmann, and Ryne A Sherman, ‘The measurement of situational influences’, *The SAGE handbook of personality and individual differences*, (2017).
- [13] Alex Kayal, Willem-Paul Brinkman, Rianne Gouman, Mark A Neerincx, and M Birna Van Riemsdijk, ‘A value-centric model to ground norms and requirements for partners of children’, in *International Workshop on Coordination, Organizations, Institutions, and Norms in Agent Systems*, pp. 329–345. Springer, (2013).
- [14] Franziska Klügl, ‘Using the affordance concept for model design in agent-based simulation’, *Annals of Mathematics and Artificial Intelligence*, **78**(1), 21–44, (2016).
- [15] Ilir Kola, Catholijn M Jonker, and M Birna van Riemsdijk, ‘What does it take to create social awareness for support agents?’, in *International Workshop on Engineering Multi-Agent Systems*. Springer, (2019).
- [16] Ilir Kola, Catholijn M Jonker, and M Birna van Riemsdijk, ‘Who’s that?-social situation awareness for behaviour support agents’, in *International Workshop on Engineering Multi-Agent Systems*, pp. 127–151. Springer, (2019).
- [17] John Bruntse Larsen, Virginia Dignum, Jørgen Villadsen, and Frank Dignum, ‘Querying social practices in hospital context’, in *10th International Conference on Agents and Artificial Intelligence*, pp. 405–412. SCITEPRESS Digital Library, (2018).
- [18] Kurt Lewin, *Principles of topological psychology*, New York, NY: McGraw Hill, 1936.
- [19] Sandy Manolios, Alan Hanjalic, and Cynthia CS Liem, ‘The influence of personal values on music taste: towards value-based music recommendations’, in *Proceedings of the 13th ACM Conference on Recommender Systems*, pp. 501–505, (2019).
- [20] Karen L Myers and Neil Yorke-Smith, ‘Proactivity in an intentionally helpful personal assistive agent.’, in *AAAI Spring Symposium: Intentions in Intelligent Systems*, pp. 34–37, (2007).
- [21] Amir Padovitz, Seng Wai Loke, and Arkady Zaslavsky, ‘Towards a theory of context spaces’, in *IEEE Annual Conference on Pervasive Computing and Communications Workshops, 2004. Proceedings of the Second*, pp. 38–42. IEEE, (2004).
- [22] F. Pedregosa, G. Varoquaux, A. Gramfort, V. Michel, B. Thirion, O. Grisel, M. Blondel, P. Prettenhofer, R. Weiss, V. Dubourg, J. Vanderplas, A. Passos, D. Cournapeau, M. Brucher, M. Perrot, and E. Duchesnay, ‘Scikit-learn: Machine learning in Python’, *Journal of Machine Learning Research*, **12**, 2825–2830, (2011).
- [23] Lawrence A Pervin, ‘A free-response description approach to the analysis of person-situation interaction’, *ETS Research Bulletin Series*, **1975**(2), i–26, (1975).
- [24] John F Rauthmann, David Gallardo-Pujol, Esther M Guillaume, Elysia Todd, Christopher S Nave, Ryne A Sherman, Matthias Ziegler, Ashley Bell Jones, and David C Funder, ‘The situational eight diamonds: A taxonomy of major dimensions of situation characteristics.’, *Journal of Personality and Social Psychology*, **107**(4), 677, (2014).
- [25] John F Rauthmann and Ryne A Sherman, ‘Measuring the situational eight diamonds characteristics of situations: An optimization of the rsq-8 to the s8*.’, *European Journal of Psychological Assessment*, **32**(2), 155, (2016).
- [26] Milton Rokeach, *The nature of human values.*, Free press, 1973.
- [27] Shalom H Schwartz, ‘Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries’, *Advances in experimental social psychology*, **25**(1), 1–65, (1992).
- [28] Shalom H Schwartz, ‘Human values’, *European Social Survey Education Net*, (2005).
- [29] Shalom H Schwartz, ‘An overview of the schwartz theory of basic values’, *Online readings in Psychology and Culture*, **2**(1), 2307–0919, (2012).
- [30] Ryne A Sherman, Christopher S Nave, and David C Funder, ‘Properties of persons and situations related to overall and distinctive personality-behavior congruence’, *Journal of Research in Personality*, **46**(1), 87–101, (2012).
- [31] Myrthe Tielman, Willem-Paul Brinkman, and Mark A Neerincx, ‘Design guidelines for a virtual coach for post-traumatic stress disorder patients’, in *International Conference on Intelligent Virtual Agents*, pp. 434–437. Springer, (2014).
- [32] Myrthe L Tielman, Catholijn M Jonker, and M Birna van Riemsdijk, ‘What should i do? deriving norms from actions, values and context’, in *10th International Workshop on Modelling and Reasoning in Context*, (2018).
- [33] Juan Ye, Simon Dobson, and Susan McKeever, ‘Situation identification techniques in pervasive computing: A review’, *Pervasive and mobile computing*, **8**(1), 36–66, (2012).

A User Study Survey

The survey can be accessed in the following link: https://tudelft.fra1.qualtrics.com/jfe/form/SV_bsdYhZLjbJH64zX

A.1 Part 1 - Collecting Situations

Introductory text: In this part, you will be asked to describe two situations involving you and one other person that occurred in your life during the previous weeks. Try to think of situations in which a concrete activity took place (e.g., not a situation such as “I saw someone in the street and said hello”). Describe the situation in 3-4 sentences, and focus on describing the activity, your relation to the other person, as well as how each of you behaved in the situation. Think of concrete and specific situations that actually took place, and not of “situation types”. Please, think of two diverse situations (i.e., they involved different people, and different activities took place). After describing the situations, you will be asked some general questions about them.

For each situation, the following questions were asked:

- Please describe the situation.

- When did the situation that you just described take place, approximately? (day and time)
- What was the main activity that took place in that situation?
- Where did the situation occur? Please do not give the exact address/name of the place, the type of place suffices (e.g. at a bar, in my office, etc.).
- What's the role of the other person that is present in the situation? (e.g. "child" would suggest that that person is your child). options: {*partner, parent, sibling, child, friend, extended family member, neighbor, coworker, supervisor, member of the same group (e.g., sports team), other*}
- Equality;
- Broad-mindedness;
- Protecting the environment;
- Helpfulness;
- Loyalty;
- Humbleness;
- Respect for tradition;
- Obedience;
- Self-discipline;
- Safety;
- Health;
- Wealth;
- Authority;
- Capability;
- Success;
- Pleasure;
- Enjoyment of life;
- A varied life;
- An exciting life;
- Creativity;
- Independence.

A.2 Part 2 - Psychological Characteristics of Situations

For each situation, participants were presented with the text of their described situation, and for each situation they were asked:

"How much does each of these statements apply to the situation that you just described?". options: {*Not at all, Very little, A little, Moderately, A lot, Very much, Totally*}

- A job needs to be done.
- I have to fulfill my duties.
- Task-oriented thinking is required.
- The situation contains intellectual stimuli.
- There is the opportunity to demonstrate intellectual capacities.
- Information needs to be deeply processed.
- I am being blamed for something.
- I am being criticized.
- I am being threatened by something or someone.
- The situation is sexually charged.
- Potential sexual or romantic partners are present.
- Physical attractiveness is relevant.
- The situation is joyous and exuberant.
- The situation is pleasant.
- The situation is playful.
- The situation could entail frustration.
- The situation could elicit stress.
- The situation could elicit feelings of tension.
- It is possible to deceive someone.
- Someone in this situation could be deceived.
- Not dealing with others in an honest way is possible.
- Communication with other people is important or desired.
- Close personal relationships are important or can develop.
- Others show many communicative signals.

A.3 Part 3 - Personal Values

Introductory text: Personal values represent things that can be important to you in life. Different situations can promote or demote some specific values. For example, skiing can promote values such as pleasure or having an exciting life, but on the other hand it can demote values such as safety, since there's always the chance of getting hurt. In the last part of this survey you will be presented with a list of values, and for each of them you will be asked to answer to what extent they would be promoted/demoted in the situations that you described in the first part of the survey.

For each situation, participants were presented with the text of their described situation, and for each situation they were asked:

To what extent does this situation promote/demote each of these values? options: slider from -10 (fully demote) to 10 (fully promote), where 0 is marked as 'neither promote nor demote'.