



STOCKHOLM UNIVERSITY

Risk Analysis, Social and Decision Research Unit

Department of Psychology

Stockholm University

**Prospect for future research based on Differentiation and Consolidation Theory:  
Distorting facts in search of cognitive coherence and individual decision  
processes in a social context**

Ola Svenson

## 1. Introduction

In the early morning, 06:46 a.m. on 27 February 2007 two buses driving against each other collided on the road between Uppsala and Östhammar. Six people died in the accident. The speed limit on this part of the road was 90 km/h and the speeds of the buses were 85 and 89 km/h when they collided. Discussions about changing the speed limit from 90 to 70 km/h had preceded the accident and the debate about the speed limit had been going on for years. The heated debate about speed limit was won by those who trusted intuitive estimates of travel time savings if the speed limit remained 90 km/h compared to 70 km/h and ignored aspects, such as, actual time saved, the lower risk of a collision and the decreased severity of an accident if it had occurred at 70 km/h. Expert opinion about these factors was ignored.

The present project links to situations like the above, because it studies social factors, intuitive unaided decisions, decisions as perceived in the "rear-mirror" and mental reactions when a decision maker realizes that a decision was wrong.

### 1.1 Organization

The project is international and provides a link from senior researchers to a younger generation, in the same way as the 2010 VR support to the Principal Investigator (PI). The earlier project on judgment biases in everyday life, with a topic different from the present one, resulted in international cooperation and publications<sup>1</sup>. It also generated a project proposal to Riksbankens Jubileumsfond extending the project. It was submitted by Gabriella Eriksson as PI, who as a young Ph D student participated in the earlier VR project and became an expert in judgment research.

In the present proposal, we want to study decision making based on Svenson's decision theory, Differentiation and Consolidation Theory, Diff Con and want to introduce Ph D students Nichel Gonzalez (Stockholm University), Sebastian Cancino (Stockholm University) and Marcus Mayorga (University of Oregon) as the next generation of decision researchers. Gabriella Eriksson, Ph D will participate and pursue her scientific career as a researcher within the new project. Ilkka Salo, Ph D (Lund University) and Joshua Weller, Professor (Oregon State University, Decision Research) who have long experience with decision research in general will join and add their expertise. The PI (Stockholm University and Decision Research), Torun Lindholm, Professor (Stockholm University) and Paul Slovic, Professor (Decision Research and University of Oregon) represent the most senior researchers of the team. Experiments will be run both in Sweden and in the US.

Decision Research, [www.decisionresearch.org](http://www.decisionresearch.org), is a non-profit research organization in Oregon.

### 1.2 Science

The majority of contemporary decision research investigates single individuals without paying attention to social factors that may influence their decision processes<sup>2</sup>. In the present project we will deviate from main stream decision research and focus on effects of social factors on an individual's cognitive decision processes.

When people look back at their prior decisions they are not always aware of the importance of social factors, such as, the views of peers or people whom they respect and relate to (Chartrand, 2005). To illustrate, Svenson, Salo and van de Loo (2007), who studied decision makers' (DMs') post hoc memories of the most important decisions of their lives, found that the judged importance of "what others would think" about their decisions was comparatively small in relation to a number of other factors or reasons. However, Feldman-Stewart et al. (2004) found that a significant minority of patients making a very difficult treatment decision referred to doctors and fellow patients as most important for their decisions. We know from decades of

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1 Ranyard & Svenson, 2011; Bäck et al., 2011; Svenson, 2011a; Svenson et al., 2011a; Svenson et al., 2011b; Svenson, 2011b; Svenson et al., 2012; Eriksson & Svenson, 2012; Svenson, 2013; Svenson et al., 2013; Eriksson et al., 2013; Gonzalez & Svenson, 2014; Svenson & Tyszka, 2014; Svenson et al., 2014; Eriksson et al., 2015; Feldman-Stewart et al., 2015. These references last after project proposal references.

2 Exceptions are, e.g., game theoretical research with two or more players, sometimes with neuropsychological measures (Rilling & Sanfey, 2011).

research, that social factors are important when people form their attitudes (Eagly & Chaiken, 1993) and make choices (Levine & Kerr, 2007) even in less serious situations. In the early days of decision research, social factors played a more important role and therefore we will turn to Leon Festinger.

Festinger wrote about a person's decision that was dissonant with the decision of a group and suggested that (1) "*The dissonance may be reduced or perhaps even eliminated by changing one's own opinion so that it corresponds more closely with one's knowledge of what others believe.....*"(2) "*Another way of reducing the dissonance would be to influence those persons who disagree to change their opinion so that it more closely corresponds to one's own.*" (Festinger, 1957 p. 182). It is possible to add, as we do in this proposal, that a third way of reducing dissonance is to project onto others changing opinions so that they approach one's own opinion.

Differentiation and Consolidation, Diff Con theory (Svenson, 1992, 1996, 2003, 2006) describes and predicts how mental representations of a decision problem during (differentiation) and after a decision process (consolidation) change in support of a preliminary or finally chosen alternative.

The proposal will explore differentiation and consolidation processes in social contexts as in the first of Festinger's statements. This will be done using a theoretical frame of reference described in the next paragraph. We will study the influence of reference groups, significant others and experts on differentiation and consolidation. We call this *direct* social differentiation and consolidation.

Instead of reducing by "influencing those persons who disagree to change their opinion..." as proposed by Festinger, we will investigate a DM's *imaginings of how others change* towards one's own representation of a decision problem. We will study how a DM imagines or perceives how others have changed their mental representations of facts, reasons and attractiveness to approach coincidence with the DM's own representation of decision problem. We call this *projected* social differentiation and consolidation.

Differentiation and consolidation processes are cognitive and/or perceptual. Therefore, we will study both distortions of mental representations and perceptions. We know that there are individual differences in structural decision making studies (Bruine de Bruin, Parker & Fischhoff, 2007; Del Missier, Mäntylä & Bruin, 2012) and we want to follow this up in a process oriented framework. Appelt, Milch, Handgraaf and Weber (2011) provided a review of individual differences measures and we will use some of these in the studies. To exemplify, dissonance creates unease and anxiety and a need for coherence and therefore we predict a hypothesized positive relationship between change of mood and conflict reduction in differentiation and consolidation.

## **2. Theory**

### **2.1 Differentiation and Consolidation Theory, Diff Con**

#### **2.1.1 Background**

The idea of consistency dates back at least to the Gestalt school of psychology of the 1930:ies with the principles of proximity, similarity, good continuation, common fate and closure of elements guiding perception (Helson, 1933; for a summary see Dember, 1961). Festinger followed these principles with his concepts of dissonance, consonance and the drive to eliminate dissonance by changing elements of perception to cognitions, that are relevant for beliefs, attitudes and decision making. Consistency has played a great role in many early theories of social psychology (e.g., Heider, 1946; Osgood and Tannenbaum, 1955; Brehm & Cohen, 1962; Bem, 1965, 1967). Janis and Mann (1977) used dissonance theory as the foundation for their decision process theory. Holyoak and Simon (1999) investigated the role of consistency (coherence) in decision making, Glöckner and Betsch (2008) developed a constraint satisfaction model for the creation of coherence in decision processes. Harmon-Jones and colleagues developed the dissonance model further (Harmon-Jones et al., 1996). Russo and colleagues have studied distorted information processing in support of a leading alternative in decision processes (Russo et al., 1996). Payne and coworkers studied construction of preferences (Bettman et al., 1998). DeKay, Miller, Schley and Erford (2014) give an overview of information distortion and coherence in decision making and Harmon-Jones and colleagues studied dissonance and neuro-psychological measures (Harmon-Jones et al., 2012; Harmon-Jones et al., 2011). Schacter (2012) summarizes research in general on adaptive constructive processes of memory serving the purpose of coherence.

#### **2.1.2 Diff Con**

Svenson developed Differentiation and Consolidation Theory (Svenson, 1992, 1996, 1998, 1999, 2003,

2006), which is a dynamic, detailed and specific coherence theory for reduction of cognitive dissonance. Diff Con has its roots in an early paper by Svenson (1979) covering process tracing research at the time. A decision problem is represented by aspects/reasons on attributes X alternatives in Diff Con. In comparison with Dissonance theory and other approaches that are focused on holistic evaluations (Brehm, 1956; Alós-Ferrer & Shi, 2015), Diff Con describes how representations of aspects on individual attributes and alternatives change during and after a decision and the rules that may achieve this.

Diff Con differs from other approaches because it does not analyze data according to labels of attributes (e.g., salary/distance to a job). Instead, Diff Con, aggregates data across individuals according to each individual's *rank order of importance* of attributes. To illustrate, the attributes of job A (salary high, travel long) and job B (salary medium, travel short) may be evaluated differently by DM1 (ranks *salary* most important) and DM2 (ranks *travel* as most important). Then, Diff Con research has found that DM1 processes the salary information in the same way as DM2 treats travel information. That is why aggregation to group data follows rank order of attribute importance and not attribute labels. Also, in contrast with most concurrent decision theory, Diff Con does not give *probability* (e.g., SEU theory) and *time* (e.g., in discounting) any specific roles; instead they are modeled as attributes among other attributes.

Differentiation involves structuring and restructuring of alternatives. First, there is *between alternative differentiation*. This means that reasons, attractiveness and facts gradually over time seem to speak more and more for the chosen alternative, in comparison with the non-chosen alternative(s) during the differentiation process. *Within alternative differentiation* means that a chosen alternative is structured so that all attributes become coherently supporting a choice. And a non-chosen alternative becomes more coherently poor than the chosen alternative. Differentiation may continue after a decision and is called *consolidation*. It serves the purpose of defending the decision as coherent, a good gestalt, protected against regret and disappointment etc. Differentiation and consolidation can be studied as processes concurrent with the decision (Svenson & Jakobsson, 2009) and consolidation can be studied in memory representations (Svenson, Salo & Lindholm, 2009). A *conflict attribute* speaks against a decision maker's choice and creates dissonance that can be eliminated in differentiation and consolidation. Individual differences in differentiation and consolidation have not yet been investigated and this is one of the purposes of the project.

Table 1 Examples of patterns of attractiveness changes to support a chosen alternative. Note, the changes are *relative* meaning that if there is a general trend over time to increase or decrease attractiveness in the table occurs relative to the general trend.

Alternative			Diff Con pattern			
	Attribute 1	Attribute 2	Attribute 3	Composite Diff Con measure	Composite Diff Con measure	Composite Diff Con measure
Chosen	Increase	Increase	Unchanged	Increase	Increase	Unchanged
Non-chosen	Decrease	Unchanged	Decrease	Decrease	Unchanged	Decrease

### 2.1.3 Measures of differentiation and consolidation

There are different ways of differentiating/consolidating attractiveness and facts (Svenson & Shamoun, 2002; Svenson, 2003). *Attribute wise analysis* compares attractiveness of aspects and facts before and during a decision process on the most important, second most important attribute etc. In addition, changes of importance of attributes, reasons and facts can also support a choice. The measures can change in different ways to support a chosen alternative as described in Table 1. A *composite measure* of differentiation and consolidation combines the effects across all attributes in one measure.

### 2.1.4 Previous Diff Con research

Diff Con has been tested in many different empirical contexts<sup>3</sup>. To illustrate, Svenson and Hill (1997) found

<sup>3</sup> (Svenson & Malmsten, 1991; Svenson & Benthorn, 1992; Svenson et al., 1994; Svenson & Malmsten, 1996; Svenson, 1997; Svenson & Hill, 1997; Svenson & Shamoun, 1997; Svenson, 1998; Svenson, 1999; Hammarberg

that prior disadvantages were transformed into advantages in support of a decision after the decision. Svenson and Jakobsson (2009) followed students who were making a decision of future profession and reported how arguments for and against the chosen alternative changed to support the preliminary and final decision during several months. Svenson and Malmsten (1996) showed that depending on outcome of a decision, receiving a less valued product increased its attractiveness even above an earlier superior but now unavailable product. Svenson and Shamoun (2002) described different patterns of differentiation and consolidation. While the overall judged attractiveness of alternatives do not always change during a decision process, the pattern of support for the preferred alternative does. For example, a conflict attribute is upgraded, the second most important attribute is bolstered while the most important (and decisive) attribute supporting the chosen alternative is not and may even decline somewhat (Svenson, 2003). This result contrasts with most studies investigating, e.g., "distortions" of complete decision alternatives, in which the most promising alternative gains and a competitor loses in holistic attractiveness over time (Russo, Medvec & Meloy, 1996).

Diff Con was used as the theoretical foundation for a decision aid (Feldman-Stewart, et al., 2004) applied on a large scale to help patients to make informed decisions among alternative treatments of prostate cancer. A later study (Feldman-Stewart et al., 2015) tested the theory and found that differentiation/consolidation distortions remained after 3 months and diminished after a year.

## **2.2 Reference group, significant other and expert, decision context and content**

Festinger (1950) pointed out that there exists a drive to determine whether one's opinions are "correct" or not in relation to a social group. Hyman (1942) used the term *reference group* in a study of social status where he asked his participants with whom, a person or a group they compared themselves. We will use perceived reference groups and investigate their role in different decision processes (Bearden & Etzel, 1982). Most research on reference groups has focused on abilities where the reference groups provide standards for judging oneself (Kahan et al., 2011; Kruglanski & Higgins, 2007; Rini et al., 2011). A person's *significant other* can be defined as e.g., "as a person whose opinion matters the most to me". Zimet, Dahlem, Zimet and Farley (1988) developed a multidimensional scale of perceived social support and used the following to characterize a significant other as a person who (1) *is around when I am in need*, (2) *with whom I can share my joys and sorrows*, (3) *is a special person who is a real source of comfort to me* and (4) *is a special person in my life who cares about my feelings*. A significant other is a real person, while the reference group is a group or category of people who is important to the DM and to whom the DM relates (Andersen et al., 1996; Faria, Krause & Krause, 2010; Lewin, 1952; Scharfstein & Stein, 1990). An *expert* is a person whose professional knowledge and or skill has developed during a long time (Ericsson, Nandagopal & Roring, 2009). An expert can present facts but must be trustworthy to influence others. The context of a decision problem stands for the situation in which a DM finds herself (e.g., physical surroundings, time pressure, negative mood). The content of a decision is the problem in itself (e.g., task and labels of attributes).

## **2.3 Individual differences**

Cialdini and colleagues developed a scale that measures individual differences in the preference for consistency (Cialdini et al., 1995; Guadagno & Cialdini, 2010), which is relevant for dissonance and the need of stronger differentiation and consolidation for those high on the scale. Another relevant scale is the need for cognition scale (Cacioppo, et al., 1984). Vallacher and Wegner (1987) used a scale measuring individual differences in level of action identification and abstract thinking (e.g, purpose of an act or the concrete act in itself), Behavior Identification Form. They found that when people do something they did not expect themselves to do, this was associated with an elicitation of more abstract thinking. Thus, dissonance was solved by moving to higher level of abstraction. This is a promising finding that will be explored in the project. This is one kind of high level and low level construals as in the Liberman and Trope (2010) Construal-level theory. We will also use the Gestalt Completion test (Liberman & Trope, 2008) with the purpose of finding out relations between level of consolidation and gestalt completion. Bruine de Bruin et al. (2007) developed a measure of adult decision making competence, (A-DMC). We will relate scores on that scale with consolidation in some experiments. A mood scale will be used to get measures of how mood co-varies with differentiation and consolidation and we predict that successful differentiation and consolidation

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& Svenson, 2000; Lundberg & Svenson, 2001; Salo & Svenson, 2001; Shamoun & Svenson, 2002; Feldman-Brundage et al., 2004; Svenson & Jakobsson, 2010; Svenson et al., 2009; Bäck et al., 2011)

will be associated with more positive mood because of dissonance reduction.

### **3. Method**

#### **3.1 General**

The methods will be experimental and analyze (1) judgments of alternatives at different stages in decision processes, (2) decisions and (3) verbal protocols. The studies will collect measures of *cognitive* (e. g., memory) and *perceptual* (e.g., structuring of concurrent perceptions) processes.

We will use multi-attribute representations of decision alternatives. Each alternative is represented by a set of aspects (facts) on attributes and the information will be numerical or on VAS scales. Participants will be asked to judge facts and their importance before and after a decision from memory or in response to a simultaneously perceptually available set of current alternatives. The judgments will be numerical or given on VAS scales. Changes in the *pattern* of judged values of facts, importance, attractiveness and strength of reasons reflect differentiation and consolidation and degree of restructuring of these variables will be the main dependent measures. Measures of individual measures will be added in most experiments. From patterns of changes we will infer rules. We will not mention process tracing measures in the project plan further. When we have found a structural change, we will apply process measures (e.g., verbal protocols) to understand the processes behind change from one structure to another.

#### **3.2 Research strategy and participants**

Each study includes different experiments and the first of these will show that differentiation and/or consolidation is affected by the specific manipulations of the study. (Some pre-experiments have shown effects that made us confident in developing this project.) Following this, we will run experiments with more participants and include different individual difference measures. The number of participants will be determined based on previous studies and will be about 40 for each condition in the initial experiment of a study and an increased number when individual differences are investigated. We will recruit as participants, students, members of the Decision Research panel (with a couple of 1000 persons with known demographic factors) and Amazon Mechanical Turk.

#### **3.3 Social psychological factors**

The project focuses on the role of social psychological factors on differentiation and consolidation. We manipulate these factors and register how they affect differentiation and consolidation (e.g., new attributes, new reasons, distorted fact representations, changed attractiveness, imaginations of how others would judge alternatives) and preference for different alternatives. Questionnaires will be used to specify, e.g., a significant other for each person and experts and reference groups will be identified in preliminary interviews. We will use instructions to communicate social factors (successful in preliminary experiments), but if not sufficient for eliciting social effects in all contexts, we will use stooges.

### **4. Examples of decision problems used in the studies**

The decisions will include but not at all be restricted to the following. In the description of a study in the project one problem will be selected as a prototype for different problems.

#### **4.1 Ethical problems**

*To prioritize a patient for surgery* (Svenson, Salo & Lindholm, 2009). One of two patients who is given surgery will survive with given probabilities and the patient not given surgery will die. The vignettes will describe the patients on 5 VAS scales, (1) Age of the patient, (2) Expected survival time without surgery in months, (3) Probability of surviving surgery, (4) Probability of surviving 5 years if having survived surgery, and (5) Expected quality of life if surviving surgery. Greater values on scales (3), (4) and (5) speak for priority of surgery, while the opposite is true for scales (1) and (2). Slovic and co-workers have studied another ethical problem, *donation decisions* (Dickert et al., 2011) and this problem will be introduced in some studies as well as other ethical or moral dilemmas.

## 4.2 Problems inviting wrong decisions

*Savings of travel time* on one of two roads that can be reconstructed to increase traffic capacity and save travel time. Both roads are 100 km long, the construction costs are the same. The task is to select the road that would save most travel time after reconstruction.

	Alternative A	Alternative B
<i>Distance</i>	100 km	100 km
Present mean speed	30 km/h	60 km/h
Mean speed after reconstruction	45 km/h	120 km/h

Following the time saving bias, most DMs will choose B for reconstruction (Svenson, 2008). But, A saves more time than B according to physics. This problem will be expanded (e.g., different speeds, costs, distances in studies of how subjective representations (e.g., importance, integration of facts, evaluations) change in the light of emerging facts about correct interpretations of facts. A *industrial productivity increase* problem (Svenson, 2011) with the same factual and numerical information as a corresponding time saving problem will also be used- Other biases, e.g., the Asian disease problem (Tversky & Kahneman, 1981) will also be used.

## 5. Studies

The main purposes of the project are to study:

**Theory** and develop Diff Con to include differential psychological factors, social factors and contemporary research.

### **Experiments**

#### **Experiments: cognition**

- Direct social differentiation and memory consolidation
- Projected social differentiation and memory consolidation.

#### **Experiments: perception**

- Direct social perceptual differentiation and consolidation.
- Projected social perceptual differentiation and consolidation.

#### **Experiments: cognition and perception**

- When DM understands that decision was wrong: revised consolidation.

#### **Experiments: empirical relationships social and individual factors**

- Relationship social and individual differentiation and consolidation.
- Relationships consolidation, mood and individual characteristics of DM.

## 5.1 Diff Con Theory

### **Study 1: Development of Diff Con theory**

Diff Con was developed for single person decision making, that is, *personal* differentiation and consolidation, without any particular references to social contexts or other persons, even though such factors could be included as one of several attributes (Feldman-Stewart, et al., 2004).

**Problem:** To develop and extend Diff Con theory based on concurrent decision research and theory. This means including also detailed modeling of influences from different social factors in cognitive and perceptual structuring and restructuring of decision problems.

**Method:** Theoretical analysis and development based on recent theoretical, methodological and empirical international advancements including results from the present project. We will extend the theory and, for instance, divide *Personal* differentiation and consolidation into (1) *Individual* consolidation and differentiation that takes place without any reference to social context or other persons and (2) the effects of social influences on differentiation and consolidation called *Direct social* differentiation and consolidation. Hence, *personal* differentiation and consolidation includes both individual and direct social differentiation and consolidation. *Projected social* differentiation and consolidation is when a DM attributes to another person changes of the other person's representation of a decision problem so that it becomes more coherent with the DM's own view. These and other concepts needed to include recent findings in decision research will be included in the theory.

**Expected results:** An improved and extended Diff Con theory.

**5. 2 Cognitive differentiation and memory consolidation: Influence of other's decision on own decision processes** - Every study of a project includes more experiments than the prototypical experiment described in each study.

**5.2.1 Medical problems**

**Study 2A Reference group decision and memory consolidation of own decision: Ethical problem.**

**Problem:** To what extent and how does knowledge about a reference group's decision in conflict or in accordance with own decision influence consolidation processes?

**Hypotheses:** One hypothesis is that after a personal decision has been made and found to be in *conflict* with a reference group's decision the DM will consolidate her or his own decision to a *greater extent* than if this information was not available. This hypothesis is supported by the results of Hammarberg and Svenson (2000), who studied joint real life decisions with outcomes for the whole group and found that those who made *another decision* than the majority of a group *consolidated their own decisions more* than those who made the same decision as the majority of the group. If a DM makes the *same decision* as a group, *less consolidation* can be expected (Eisele, 2000). This and a study by Lindholm et al., (personal communication) support the hypothesis that decisions with knowledge about a reference group's decision will be less consolidated than decisions without this information if the decisions are congruent with each other. We hypothesize that direct social consolidation, such as, downgrading of the importance, competence and trustworthiness of the reference group will be part of the consolidation processes in addition to regular cognitive consolidation. Greater consolidation will correlate with more positive mood after decision.

**Method:** The reference group will be students like the participants themselves. One experiment will use the surgery priority decision problem: (1) Facts on attributes are given on VAS scales and the participant will judge the importance of the facts and make a priority decision. (2) The participant is given questions about, e.g., trust in and competence of the reference group to make such a decision and how similar the participant is to the average reference group member. (3) A participant in the experimental group is informed that in a previous related study (publication that they will be given after the experiment - Svenson, Salo & Lindholm, 2009), students like themselves prioritized treatment of the man (M)/ woman (F). (4) The participant is asked to try to understand how it was possible for the reference group to make this decision and give 3 written reasons for such a decision. (5) Unrelated activity. (6) The DM will recall the facts from memory and replicate them on empty VAS scales as well as prior importance judgments. The participant can change the prior decision. (7) The judgments concerning the reference group are repeated. (8) Measure of experienced degree of decision conflict, mood before and after study as well as involvement and other measures of individual differences will be collected.. The recalled facts and their judged importance will be compared with a control group with no mention of a reference group decision according to the scheme below. A second control group will judge the facts without a decision.

Table 2 Outline of experimental design excluding second control group without decision.

Decision problem: Participant decision and judgments of facts and reference group	Info about reference group decision	Unrelated activity	Participant's repeated judgments, decision and facts (consolidation).
Male (M)	Ref group decision (M)		"
Male (M)	Ref group decision (F)		"
Decision	----- no info control-----		"
Female (F)	Ref group decision (F)		"
Female (F)	Ref group decision (M)		"

**Expected results:** The primary dependent measures will be reproduced facts and their judged importance as measures of direct social consolidation. Changes in judged trust, competence, mood etc of the reference group will also be described. Hypotheses listed above will be tested, decision processes modeled and the impact of a reference group on a person's decision processes will be modeled using Diff Con.



## **Study 2B Significant other's decision and influence on memory consolidation of own decision: Ethical problem.**

**Problem:** To what extent does knowledge about a significant other's decision that is opposite to or in accordance with own decision influence consolidation? Which processing strategies will be applied in the consolidation processes compared to a control group and to a reference group?

**Hypotheses:** The same as in Study 2A, but with stronger effects of the manipulation and greater involvement

**Method:** We will first have each participant determine and name a most significant other, using a questionnaire based on the work by Zimet, Dahlem, Zimet and Farley (1988). After this, the procedure will follow Study 2A with an identified significant other replacing the reference group.

**Expected results:** Results corresponding to those of Study 2A. We will compare results from the studies and expect stronger consolidation with a significant other moderated by individual difference characteristics of the DM and significant other.

## **Study 2C Expert decision and influence on memory consolidation of own decision: Ethical problem.**

**Problem:** To what extent does knowledge about an expert decision that is in conflict or in accordance with own decision influence consolidation? Which processing strategies will be applied in the consolidation processes?

**Hypotheses:** As in 2A,B and there will be a positive correlation between the experts' judged competence and consolidation.

**Method:** We will use different expert groups (e.g., nurses, doctors) and measure trust. The remainder of the study follows the pattern of Study 2A.

**Expected results:** Comparable with studies 2A and B, but on average with strongest differentiation/consolidation and frequency of decision reversals when greater trust in the expert. The results of studies 2A-C will influence later studies.

### **5.2.2 Content and decision processes**

#### **Study 3 Personal memory consolidation: congruent information but different content and framing.**

Miller et al. (2013) studied predecision distortions across different domains and could not find any differences. However, their design only evaluated the difference in attractiveness and did not measure differences in differentiation for different alternatives and attributes.

**Problem:** To investigate if and how content and framing affect consolidation processes. We will design a lottery decision numerically similar to the surgery problem in study 2. The problem is also similar to choice situations in some popular tv programs.

**Hypotheses:** We hypothesize that the facts and importance consolidation will parallel those in the ethical problem, but be weaker because of the non-ethical conflict character of the problem. Research on gambling behavior indicates that people may take greater risks when the outcomes are more negative (Landman,1987). If participants perceive that the risk of losing a life looms larger in the first round of the surgery decision than food in the lottery decision we expect that greater risks will be taken in the surgery than in the lottery context. This is because loss of life right away is worse than loss of food. But, this is a two stage scenario and we are open to any results. However, we expect more consolidation in the surgery problem because it is more important that this decision comes out right in the mind of the DM. We will investigate positive and negative frames (gain/loss) to get a fuller picture of consolidation, problem and context .

**Method:** We will use the same general design as Study 2. One group of participants will be given the surgery problem but initially with only two attributes (probability of surviving surgery and of living 5 years after surgery). Another group will be asked to choose between two lotteries with food prizes for 0.5 and 4.5 years for a 4 member family. The probabilities in the two conditions (surgery/lottery) will be the same and the judgments given on VAS scales. We will present problems in positive and negative frames. In one experiment, a participant will be asked to imagine that, e.g., a significant other (or reference group) has made a specific choice (in conflict or in accordance with own decision) and asked to provide reasons for the decision made by the significant other.

**Expected results:** Differences in consolidation processes due to content and framing. The influence of significant other or a reference group on own decision will be modeled in Diff Con concepts including social

consolidation.

### **5.2.3 Realizing that facts speak against own decision.**

#### **Study 4 Post decision memory consolidation: someone explains that the decision was wrong and based on incorrectly interpreted facts.**

**Problem:** To investigate how participants consolidate or change and possibly differentiate a new decision when they realize that it was wrong and based on erroneous use of facts.

**Hypotheses:** One hypothesis is denial of facts, ignoring them. Further, the DM may find a new decision goal and stay with the decision. Another hypothesis is decreasing support for chosen alternative and change of decision. The size of the difference between correct and intuitive outcomes will affect decision reversal and the restructuring process and this will be followed up in sequels of the initial experiment. We predict that that primarily less important attributes will be used in restructuring of a reversed decision, but do not know how consolidation affects the perception of numbers describing the chosen/non-chosen alternative. We have no specific hypotheses about individual differences but have run a small preliminary experiment that shows interesting differences between those who stay with a decision against strong contradictory facts and those who change.

**Method:** The road improvement decision problem (and e.g., Asian disease problem) will be used to induce an incorrect decision and VAS scales will be used to judge numerical information. The design of Study 2 will be used. Different measures will be used to study facts consolidation as well as other measures of individual differences.

**Expected results:** Descriptions of how consolidation proceeds when the outcome of a person's decision was found to be different, close to or far from objectively correct. Mood will vary depending on how the new situation was solved and decision processes will co-vary with individual characteristics.

### **5.3 Perceptual differentiation and consolidation of facts**

In the previous section we studied cognitive and memory processes. In the present section we will study restructuring of perceptions of facts that are shown to the DM during the pre- and post decision periods. The plans to investigate perceptual consolidation seem realistic and based on a successful pre-study.

#### **Study 5A Distorted perceptions of digits: Expert decision and decision maker's perceptual differentiation, perceptual consolidation and memory consolidation.**

The present study will investigate distorted perceptions of facts in front of the DM under the guise of an investigation of VAS scales. There will be experiments with experts, significant other and own reinterpretation of facts against own decision.

**Problem:** To investigate the effects of expert opinion on perceptual consolidation and distortion of digits describing decision alternatives when expert opinion conflicts or is in agreement with own decision. We will also investigate the relationship between perceptual consolidation and memory consolidation. Is it sufficient to consolidate just perceptually or is such a process followed by further memory consolidation?

**Hypotheses:** The perceived magnitudes of digits will change differently in a condition with an expert decision in conflict with intuition than in a control group. If the objective outcome of the decision is marginally different from intuitively predicted outcome participants will differentiate and consolidate perceptually more than the control group. If this outcome difference increases, differentiation and consolidation will increase, but not beyond a threshold of choice reversal leading to consolidation of the new decision. Based on earlier research, less important attributes will be restructured in support of the initial decision. We have no hypothesis concerning the relationship between perceptual and memory consolidation.

**Method:** To capture perceptions of magnitudes of digits we will use VAS scales. The study will be described as a test of VAS scales. The decision concerns, e.g., donation, surgery, Asian disease road reconstruction decisions. The time saving bias (Svenson, 2008) and other biases will be used to lead a participant to make a decision based on erroneous interpretations of facts. Participants will judge the magnitudes of the digits giving information about the two options on empty VAS scales. (1) The participants in the experimental group will first judge the numerical information without mentioning of a decision and (2) make a decision (3) judgment of information (4) the participants in the experimental group will be informed about the correct time savings /that an expert had given priority to the non-intuitive road improvement/. (5) DM asked to give reasons supporting the reinterpretation of facts /expert's/ decision. (6) judgments of

numerical information on VAS scales (and how much they speak for an alternative) (7) Unrelated task (8) The DM will make a new decision and (9) judge the facts again on VAS scales (and how much they speak for an alternative). (10) The DM judges the trustworthiness of the reinterpretation /expert/ concerning the decision. There will be a control group without the reinterpretation /expert/ and another experimental group to which the expert opinion is introduced before the decision. The strength with which an alternative is prioritized by a participant will be judged on VAS scales giving a quantitative holistic attractiveness measure. Memory consolidation will be measured in one condition and there will be a control group making no decision. Other judgments will also be collected, e.g., judgments about satisfaction with decision before and after objective facts uncovering, mood, the importance of different attributes and scales measuring individual differences.

**Expected results:** Change of magnitude perceptions of digits as a result of a decision. The influence of reinterpretation /experts/ will affect the representations depending on discrepancy between intuitive and factual outcomes. Small differences will be counteracted by stronger consolidation and greater differences by reversed decisions. Descriptions of what decision strategies are used and how they change relate to trust in the expert. Relationship between perceptual and memory consolidation.

**Study 5B Distorted perceptions of line length: Expert decision and decision maker's perceptual differentiation and consolidation.**

The results of 5A with digits measured by line length will be reversed in this study to further validate the former findings. Here, perceived changes of line length will be measured by numerical judgments.

**Problem:** To investigate the effects of expert opinion on perceptual consolidation and distortion of line lengths describing decision alternatives when expert opinion conflicts or is in agreement with own decision. Hypotheses, method and expected results mirror those of Study 5A, but for line length.

**Study 6A Distorted perceptions of digits: Perceptual consolidation after information that prior interpretation of facts and decision was wrong.**

**Problem:** To study how the perceived magnitude of numbers change in consolidation of a decision. In particular, we want to study how perceptions change when it becomes obvious that a decision was wrong. How will those who stay with a decision differ from those who change? To what extent will number perceptions of the chosen alternative be downgraded and/or the non-chosen alternative upgraded in response to having made the wrong decision? What attributes will be restructured, the most important or less important attributes and will the importance of attributes be changed?

**Hypotheses:** The initial hypotheses are the same as in Study 4, with perceptual distortion replacing memory distortion. Thus, we predict corresponding consolidation patterns for perceptual and memory consolidation and are ready for other results.

**Method:** As in Study 4, the study will be disguised as a study of VAS scales with correct information provided and explained to the DM after an initial decision and judgments. The facts will be given in numbers and the responses on empty VAS scales. In the experimental group, the participants (1) make a decision about, e.g., which road reconstruction to prioritize (Asian disease, other cognitive traps). (2) Participants judge on VAS scales the magnitude of the number information about distance, speeds and costs and also the importance of each piece of the information for the decision. (3) The problem is presented again but this time with correct computations of the time savings for the two alternatives. (4) The DM makes a second decision and gives new judgments of the numerical facts in front of the DM and their importance on the VAS scales. This experimental condition will be compared with two control groups, one with decisions but without correct information and one group with no decisions but judgments of the quantitative information.

Individual differences measures will be collected, e.g., judgments about satisfaction with decision before and after objective facts were uncovered, the importance of different attributes, individual differences scales etc.

**Expected results:** Changes of facts in perceptual consolidation as a function of discrepancy between intuitive facts and objective contradicting facts answering the suggested hypotheses. Individual differences scales will be correlated with consolidation measures.

**Study 6B Distorted perceptions of length of line in front of decision maker: Perceptual consolidation after information that prior interpretation of facts and decision was wrong.**

**Problem:** To study how the perceived length of lines change in consolidation of a decision. This is a

validation study parallel with Study 6A.

#### **5.4 Imagined changes of other's problem representations in support of own decision: Projected social consolidation.**

The effects of others on a person's own attitudes and decisions have been studied for a long time. To illustrate, Eagly and Aiken (1993) reviewed studies in motivational processes, functional and consistency views on attitudes and decision making including the phenomenon that people can project their own attitudes on another person. This section links to the latter effect.

#### **Study 7 Restructuring of how imagined other is seen to represent decision problem: projected social consolidation.**

**Problem:** How a DM imagines how another person represents a decision problem and how this *representation is changed* from before to after a decision so that it becomes more supportive of DM's decision, *projected social consolidation*.

**Hypotheses:** We test the hypothesis that a DM will seek support for a decision by changing her or his perceptions of how an expert perceives the same decision problem. We hypothesize that consolidation will be found both for own and for perceived expert and DM representations. We also predict that cognitive style, abstract-concrete thinking, need for cognition will co-vary with consolidation as well as mood as outlined earlier in the proposal.

**Method:** Participants respond on VAS scales. The problem will be introduced as, e.g., an ethical problem, for example a medical problem or a social problem (Bäck et al., 2011) with VAS scale responses. (1) The problem is presented. (2) participants judge the information and make a decision, (3) a reference/expert/significant other identified (e.g., an expert doctor), (4) the participants are given the expert decision and judgments of the facts and to what extent they support each alternative, (5) the participants are asked to list reasons for the expert decision. (6) unrelated activity, (7) participants asked to repeat or change own decision and judge the information again (8) participants replicate expert judgments and decision, (9) measures of individual differences collected (e.g., cognitive style, abstract - concrete thinking, need for cognition, involvement in task). In one control group we will give no information about expert decision and in another control group we ask for no decision. Participants will be given information about experts who made the same or opposite choice. In some experiments we will study memory consolidation and in others perceptual consolidation.

**Expected results:** We will describe projected social consolidation decision patterns for same and different participant-expert decisions and relate them to individual difference variables. We expect both individual and projected social consolidation.

#### **Study 8 Are social and personal consolidation processes compensatory?**

**Background:** Assume that a significant other person prefers another alternative than a DM. This dissonance can be resolved by the DM in (1) *personal* consolidation (includes *individual* and *direct social consolidation*) and/or (2) *projected social* consolidation in which the DM attributes to, e.g., a significant other person consolidation in coherence with the DM's own choice.

**Problem:** The problem is to investigate how social and personal consolidations are interrelated. If there is an inverse relationship between them, this indicates a compensatory relationship and that personal consolidation can be substituted or supported by projected social consolidation. A positive relationship indicates a personal tendency of generally stronger or weaker consolidation.

**Method:** The design replicates in part earlier studies. Initially, the decision problems will be characterized by only two attributes and a significant other. We will measure personal and projected social consolidation. There will be a control group in which there will be no opportunity to use social consolidation (that is no other opinion will be mentioned) providing a baseline of *individual* consolidation. Following positive results, we will search for measures of individual differences that may co-vary with projected social differentiation and consolidation.

**Expected results:** We will report how personal and social consolidation interact.

#### **Study 9 Upgrading chosen alternative or downgrading non-chosen alternative?**

**Problem:** At present, there is great interest in finding out in which situations a chosen alternative is bolstered and/or the non-chosen alternative downgraded. Nurek, Kostopoulou and Hagmayer (2014) found

considerable distortion of information to weaken the non-chosen alternative but little distortion to strengthen the leading (initially promising) alternative in the pre-decision process. They also reported individual differences in the tendency to engage in either mode of distortion and found that distortion is affected by participant and task characteristics. Svenson et al., (2009) found that both the chosen and non-chosen alternative was distorted. However, so far the person/task characteristics that trigger bolstering of a preliminary choice alternative or downgrading its competitor has not yet been specified.

**Hypotheses:** Priming selection over elimination will lead to greater use of bolstering of a preliminary chosen alternative and priming of elimination will lead to downgrading competitors. There will be systematic inter individual differences.

**Method:** Participants will be asked to select an alternative/ reject an alternative and the differentiation and consolidation processes will be followed in a “stepwise evolution of preference” method (Russo, Meloy & Medvec, 1998) with two alternatives and distortion measured on separate judgment scales. The decision content will be varied factorially (positive/negative choices X instructions).

**Expected results:** Descriptions of how bolstering and downgrading depend on decision goal, problem content and person.

### **6. Importance and uniqueness of project**

The dynamic coherence perspective of Diff Con including social factors in decision making is unique and models the influence on cognitive processes in detail not attempted earlier. The project will relate those processes to individual differences and action tendencies. The project is important for understanding decision dynamics (e.g., projection) in real life decision making in which new contradictory facts appear and social pressure is abundant. The results of the project will be relevant for individual decision making (e.g., how to cope with contradictory information) and decisions on the societal level (reactions from those with decision power when they meet social or factual disagreement with their decisions). The theoretical part of the project provides a frame of reference for studies of dynamic individual decision making down to a kind of "molecular" level and further studies of how to solve decision conflicts.

### **7. National and international cooperation**

In Sweden, Stockholm University and Lund University form the research axis of the project. This is also an international project including researchers from Sweden and USA. If Gabriella Eriksson moves to University of Leeds, it will also include cooperation with researchers in Great Britain.

### **8. Time plan**

The time plan will cover 3 years, be flexible and adapted to the emerging results and we plan the following, Year 1: experiments in studies 2,3 and 4; Year 2: studies 1, 5 and 6; Year 3 studies 1, 7, 8 and 9. Note that each study comprises several experiments.

### **9. Budget Considerations**

Budget on separate form. It includes costs for personnel, material and travel.

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