Imagining futures

Cognitive processes of desirable or undesirable project prospections

Stingl, Verena; Geraldi, Joana

Published in:
Technological Forecasting and Social Change

DOI (link to publication from Publisher):
10.1016/j.techfore.2023.122701

Publication date:
2023

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Stingl, V., & Geraldi, J. (2023). Imagining futures: Cognitive processes of desirable or undesirable project prospections. *Technological Forecasting and Social Change*, *194*, Article 122701. https://doi.org/10.1016/j.techfore.2023.122701

Technological Forecasting & Social Change 194 (2023) 122701

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

Imagining futures: Cognitive processes of desirable or undesirable project prospections

Verena Stingl [a,c,*], Joana Geraldi [b,c]

[a] Aalborg University, Department of Materials and Production, Denmark
[b] Copenhagen Business School, Department of Organization, Denmark
[c] Technical University of Denmark, Department of Management Engineering, Denmark

ARTICLE INFO

Keywords:
Risk and opportunity identification
Pragmatic prospection
Cognitive processes
Active information search
Projects

ABSTRACT

The identification of plausible desirable and undesirable future events is fundamentally a cognitive process of prospecting possible futures. Yet, organizational practices designed for the identification and management of these uncertain futures, specifically project risk management, heed little attention to the role of cognition in these processes. Building on the theory of 'pragmatic prospection', we address this gap and examine the cognitive processes involved in prospection of desirable vs. undesirable project futures while identifying opportunities vs. risks. Empirically, we analyse the information search behaviour and post-hoc search verbalization in an experimental project risk and opportunity identification task. We find that risk identification relies often on simpler approaches with lower cognitive load, while opportunities triggered more explicit information search strategies and were more prone to evoke agency within the imagined futures. These findings challenge the assumption – widely held in risk management practice – that risks and opportunities can be approached by the same processes. We conclude with an outlook on how a better understanding of the involved cognitive processes can support foresight activities in project planning and beyond.

1. Introduction

We live in a 'projectified society' where formal projects have become the main mode of shaping an uncertain future for both business and society (Lundin, 2016). There has been growing awareness concerning the role of the subjective perception of future uncertainty to understand the future-making activities in projects (Comi and Whyte, 2018; Djuricic and Bootz, 2019). Such an approach considers future uncertainty as a 'state of mind', which is subjectively perceived (and often negotiated or constructed socially) by project actors (Aven and Renn, 2009; Winch and Maytorena, 2011). Yet, this subjective perception of future project uncertainty is typically considered either as collective phenomena, such as (prospective) sensemaking (Pitsis et al., 2003; Sakellariou and Vecchiato, 2022), or, if concerned with individual cognition, focused on biases concerning judgements about the future (e.g. Flyvbjerg, 2008; Lovallo and Kahneman, 2003). Yet, in projects as entangled processes of planning and acting (Comi and Whyte, 2018), we need to consider individual cognition concerned with an uncertain future more broadly than simply as misguided estimates. Instead, we suggest to investigate how individuals form their projections of plausible futures in projects.

Despite high attention towards project uncertainty in terms of its nature (Daniel and Daniel, 2018), its perception (Sanderson, 2012), and its management (Ward and Chapman, 2003), the project literature offers no insights into how individuals form images of different plausible futures for their projects. Yet, better understanding how these insights are formed is crucial, as they can become a determinant of project dynamics (Engwall, 2003), drive engagement or disengagement in the project (Kreiner, 2014; Pinto and Patanakul, 2015), and inform decisions on courses of action in a project (Meyer, 2014).

To gain better understanding how individuals form images of plausible project futures, we turn to cognitive psychology. Framed as either processes of pragmatic prospection (Baumeister et al., 2016) or episodic future thinking (Atance and O'Neill, 2001), this body of research has studied processes through which individuals construct plausible future scenarios. One of the most central findings in the literature, are the substantial differences in the processes around the prospection of desirable and undesirable futures (Baumeister et al., 2001, 2016; Oettingen, 2012; Shepperd et al., 2013; de Vito et al., 2015). A notable early example of this line of research in psychology is prospect theory (Kahneman and Tversky, 1979), suggesting a skewed valuation of potential

* Corresponding author.
E-mail address: vstingl@mp.aau.dk (V. Stingl).

https://doi.org/10.1016/j.techfore.2023.122701
Received 20 July 2021; Received in revised form 6 June 2023; Accepted 10 June 2023
Available online 16 June 2023

losses, over potential gains. However, more recent research has found such differences in cognitive processes not only in the act of evaluating a future, but also in the construction of desirable v undesirable future scenarios (Baumeister et al., 2016; Monroe et al., 2017; de Vito et al., 2015). However, while establishing that construction of desirable vs. undesirable future scenarios are different cognitive processes, we still have limited understanding about how they differ, which is the core focus of this paper.

We find the distinction between desired and undesired futures mirrored in the most common practice for managing project uncertainty: project risk management (Ward and Chapman, 2003). Project risk management typically distinguishes between uncertain effects that create negative project outcomes ('risks') or positive outcomes ('opportunities') (Hillson, 2002). Yet, other than cognitive psychology, research and project risk management practice have called for an integration of the two concepts (Chapman and Ward, 2011; Hillson, 2002; Olsson, 2007; PMBOK Guide - Sixth Edition, 2017), rather than a separate treatment. Yet, acknowledging and characterising the differences in cognitive processes when imagining desirable or undesirable futures could help design better processes for leveraging the human ability to imagine novel futures that provide the foundation for project planning and execution. The purpose of this research is therefore to identify and characterise differences between the cognitive processes at play, when individuals imagine desirable or undesirable project futures.

Based on quantitative and qualitative experimental data and structured interviews with 42 individuals, we analyse the cognitive processes in the prospection of desirable and undesirable project futures. The research method is an abductive, mixed-method approach, based on the active information search methodology (Huber et al., 2011).

Our results indicate that the formulation of undesirable futures tends to lead to a more passive engagement with the project, thus reducing aspects of planning or mentally adapting the plan to identified obstacles. Conversely, we found that looking for concrete opportunities is cognitively more demanding and triggers more active thoughts related to overcoming barriers and construction of concrete future scenarios. These findings both add to, and challenge previous findings that had indicated that individuals would construct desirable scenarios with more ease, compared to undesirable scenarios (de Vito et al., 2015).

Our research contributes to project studies, cognitive psychology, and the practice of project risk and opportunity management. For project studies, we contribute to the growing body of behavioural studies on projects (Stingl and Geraldi, 2017) by offering novel understanding to how project futures are subjectively constructed. For cognitive psychology, we discern two different cognitive processes at play when individuals imagine an uncertain future. For practice, the findings challenge the notion that project risks and opportunities should be tackled with the same techniques, and provide an outlook how changes in practice can enhance practitioners' ability to holistically explore project futures.

2. Theoretical foundations

2.1. Management of uncertainty in projects

Despite the increasing attention to the role of human behaviour for project organizing under uncertainty (Stingl and Geraldi, 2017), the dominant practices in the management of projects still draw widely from project management's technocratic origins (Morris et al., 2011). Consequently, we find that the main modes for exploring and managing project uncertainty relate to defined processes of planning, and the identification of potential deviations from such plans due to unforeseen or uncertain trends or events (PMI, 2019; Ward and Chapman, 2003). These deviations are typically conceptualized as *negative* plan deviations ('risks') or *positive* plan deviations ('opportunities') (Hillson, 2002), which are identified, assessed, responded to, and monitored in a continuous process (Raz and Hillson, 2005).

However, practitioners and academics increasingly question the value of these established practices for management of uncertainty in projects (Willumsen et al., 2019), and have criticised the underlying notion that project uncertainty is merely a 'state-of-the-world' that can be uncovered through rigorous processes (Winch and Maytorena, 2011). The 'state-of-the-world' view, in its pursuit of objectivity and 'debiasing' uncertainty management (cf. Flyvbjerg, 2008), provides only a myopic perspective on how project practitioners *create* new prospections and *imagine* desirable and undesirable scenarios therein. As expressed by Winch and Maytorena '*[p]rojects are fundamentally about states of mind; it is only once they are completed that they become states of nature*' (Winch and Maytorena, 2011:360). This is in line with other studies that highlight that people in projects continuously engage with the future (Pitsis et al., 2003), using discourse (Musca et al., 2014) or artefacts (Comi and Whyte, 2018) to "*giv[e] form to what is 'not yet'*" (ibid., p. 1055). In this view, plans and the explication of risks and opportunities are thus not objective outcomes, but materializations of individual or shared projections about possible futures (Kreiner, 2014; Pitsis et al., 2003).

As the concepts of risk and opportunity are thus central artefacts for uncertainty management in projects, it is essential to understand how they are developed and explicated through processes of imagining alternative project futures (Rowland and Spaniol, 2015). Despite placing individual agency at the centre of prospection, project research has thus far focused on the collective development of these projections, particularly building on sensemaking theory (Sandberg and Tsoukas, 2015). However, individual cognition – that is the processing of information through the individual – is the foundation to understand collective sensemaking (Weick, 1995), yet project studies provides limited insights on individual cognition beyond notions of biased decision-making (Stingl and Geraldi, 2017). With this study we therefore focus on prospecting as process of individual cognition, understanding it as a core contributor and foundational building block of collective processes.

2.2. Prospection of desired and undesired future outcomes

Imagining future outcomes requires the individual to mentally simulate possible future scenarios and anticipate how one will experience those futures. In their seminal article, Gilbert and Wilson (2007) introduced the term 'prospection' (as antonym to 'retrospection') defined as a 'pre-feeling' of the future, in other words a prediction of one's emotions in a possible future situation. Since then, 'prospecting' has become an umbrella term for any cognitive activity concerned with the future, most notably expanding to non-affective forecasting (Shepperd et al., 2013; Tetlock and Gardner, 2016), that is, forecasting that is based on pre-established future scenarios.

In their 'pragmatic prospection theory', Baumeister et al. (2016) expand prospection from previously investigated questions of prediction and forecasting, by a 'pragmatic' element that focusses on potential actions of the prospecting individual. Pragmatic prospection, thus, is defined as '*thinking about the future in ways that will have practical utility [..] that will guide action*' (ibid., p. 4). It can thus be considered as an extension of theories on 'episodic future thinking' (EFT; Atance and O'Neill, 2001), as it not only positions the prospecting individual at the centre of the future scenario, but also highlights the individual's role as active actor in these scenarios.

The theory conceptualizes prospection as the creation of a 'matrix of maybes' (Baumeister et al., 2018) that acknowledges the plasticity of the future and the agency that the prospecting individual has in this future. It is therefore entangled with processes of conscious planning, which are core in projects. Integrating Oettingen's work on fantasy realization theory (Oettingen, 2012; Oettingen et al., 2001), pragmatic prospection theory proposes that prospecting is a cognitive process comprising of a) the definition of desirable outcomes, and b) subsequent exploration of obstacles and threats related to one's actions for reaching these outcomes. Kappes et al. (2013) found that higher self-agency in the planning step (i.e. self-defined desirable outcomes) created higher attention

to challenges and obstacles to the plan. Similarly, Monroe et al. (2017) showed that actively engaging in thinking about one's own future reversed the otherwise typically reported over-optimism of forecasts (Shepperd et al., 2013) and made individuals more attuned to possible negative outcomes. Proponents of the theory thus argue that the proposed duality of pragmatic prospection – embracing both optimistic formulation of self-defined, desirable goals, and attentive exploration of possible obstacles – allows explaining diverging findings of either over-optimism or pessimism in different studies on prospection (Baumeister et al., 2016).

This distinction between cognitive engagement with desirable and undesirable potential futures parallels other findings in cognitive science that indicate that the human mind treats desirable or undesirable expectations differently. Most notably, Kahneman and Tversky's influential prospect theory (1979) suggests that people value the pains of potential future losses asymmetrically higher than benefits of potential future gains. Other relevant findings relate to skewed predictions towards desired outcomes (Shepperd et al., 2013; Weinstein, 1980), or the stronger effect of previous negative experiences (as compared to positive experiences) when making predictions (Baumeister et al., 2001). Similarly, within the body of episodic future thinking, de Vito et al. (2015) found that individuals were able to construct of desirable future scenarios with more ease, than undesirable ones.

Thus, the discussed cognitive literature provides strong indication to distinguish prospections of desirable and undesirable futures, suggesting different underlying cognitive processes. However, the findings remain opaque when it comes to how these different cognitive processes relate to the *identification* of any such desirable or undesirable futures (as opposed to the insights on cognition around the *assessment* of likelihood or impact around pre-defined potential future scenarios).

Consequentially, and connecting the context of project uncertainty and prospection, the question guiding our research is: *What are the differences between the cognitive processes engaged in the prospection of desirable or undesirable project futures?*

3. Methods

To research the cognitive processes engaged in the prospection of desirable and undesirable project futures, we are interested in how individuals search for pertinent information, and integrate this information in the formulation of future scenarios. To this end, this study follows an abductive methodology (Haig, 2005; Ward et al., 2018), which allows integrating rigorous phenomena detection methodologies from the hypothetico-deductive approach with inductive approaches for theory construction. This approach is suitable when established theories pertaining to the empirical phenomena under study exist, yet they are inconsistent or incomplete to allow rigorous a priori hypothesis development. Considering the limited knowledge on cognitive processes involved in prospecting desirable/undesirable project futures and its complementary theoretical explanations, abductive methodology is appropriate to our study.

Following Haig's (2005) abductive approach, we start with controlled and quantitative data collection through an experimental set-up focused on identification of desirable/undesirable project outcomes to observe (albeit indirectly) how the human mind prospects different project futures. The experiment was followed by qualitative data collected through a post-experimental, structured interview. This approach generates both quantitative data for exploratory analysis in the phenomenon detection step of Haig's (2005) model, and qualitative data for grounded analysis and theory construction. The next sections describe and justify our sample strategy, experimental design and quantitative and qualitative approaches.

3.1. Sample

We sought a sample of participants who are familiar with a certain type of project, to be able to imagine desirable or undesirable outcomes, but not highly experienced nor exposed to the social intricacies and politics involved in formalized processes of risk management. Familiarity with the context is important because prospection is shaped by past experiences for both assigning meaning to specific aspects of a situation, and for mentally simulating futures based on abstract causal understanding (Atance and O'Neill, 2001; Baumeister et al., 2001; Seligman et al., 2013). Thus, to construct meaningful prospections, individuals need to have some general understanding of the project, its contextual characteristics, and typical dynamics. At the same time, we avoided experience and training in traditional risk and opportunity identification processes, as they are likely to shape particular modes of engaging with the future scenario (Kahneman and Klein, 2009; Maytorena et al., 2007). Lack of professional training allows us to investigate shared and innate cognitive process, rather than modes of prospecting that are induced through existing professional practice and training in risk and opportunity identification.

We found a suitable population in second year Master students from Danish universities where most of the academic deliveries are project-type group assignments. These assignments typically require the delivery of a unique output within constraints of time and resources, such as a prototype, a consultancy report, etc., and the students have to plan and execute work independently and in different teams at each class. Despite their experience in this kind of projects, they receive typically no systematic training in risk management. Thus, this population has the required common experience in one project setting while also being void of pre-conceptions formed through professional training and experience.

Using student as subjects to investigate judgement and decision behaviour is highly contested in fields that build on contextual experience, which can be as mundane as homemakers' consumer choices (Peterson, 2001), as highly specialized as software requirement engineering (Berander, 2004), or take place in contested arenas such as politics (Druckman and Kam, 2011). Nevertheless, student subject research is an established practice to investigate problems of cognitive psychology, which are more concerned with uncovering innate cognitive processes than the relative distribution of behavioural patterns. The tradition of research with student subjects to discover and theorize about cognitive processes has been favoured in the works of Tversky and Kahneman (1974) in uncovering fundamental heuristics at play in judgement formation. Similarly, it is at the foundation of Baumann and colleagues' work leading to the proposition of pragmatic prospection theory as a novel way to theorize about how people engage cognitively with the future. Our research problem is similarly interested in the innate processes of future cognition in project settings, aiming to theorize in a field that is relatively scant in such theoretical explanations. We thus argue that research with student subjects will allow us to identify and describe basal cognitive processes of prospection in projects – yet with the limitation that those will not illuminate the relative prevalence of these processes in the prospecting of experienced practitioners.

The sample consisted of 42 Master students with an experience of at least five project works in the past year. The sample was heterogeneous in terms of nationality and study field (see Table 1), whereas all students were enrolled in either a technical or a business Master program.

Following common practices in experimental research at our universities, participants received a compensation of 100 DKK (ca. 15 USD) and were, after successful completion of the experiment, eligible to enter a lottery for a 1000 DKK (ca. 150 USD) shopping voucher.

3.2. Experimental design

We use the Active Information Search (AIS; Huber et al., 1997) to design the experimental set-up. The method is an inverted interview setting, in which the participant actively requests information about an unknown scenario, to complete a specific decision or judgement task. That is, the participant can freely explore the information space, without guidance from the experimenter, and receives information in a

Table 1
Overview of participant demographics.[b]

Total	42 (14 female)
Age	23.9 (σ: 1.64; min: 20; max: 30)
Nationality	French (7), German (5), Greek (5), Danish (4), Italian (3), Indian (3), Spanish (3), Chinese (2), Norwegian (1), Romanian (1), Estonian (1), Russian (1), Turkish (1), USA (1), Dutch (1), Iranian (1), Hungarian (1), Polish (1)
Project group work[a] experience	5–10 group works: 32 more than 10 group works: 10
(Current) study field	Engineering: 18 Technical Design: 6 Management/Business: 18

[a] Project work defined as: "Assignments that have a clear deliverable (report, prototype,..) and require project-like self-organization (setting goals, dividing tasks, scheduling & planning, …)".

[b] Our sample started with 43 students. One participant was removed from the sample because of a misinterpretation of the task that lead to insufficient engagement with the scenario.

standardized form. AIS has been successfully applied to study the risk identification behaviour of construction practitioners (Maytorena et al., 2007; Winch and Maytorena, 2009), and provides a naturalistic approach to capture participants' information search behaviour associated with exploring plausible project futures. It therefore provides a glance into the actual cognitive processes at play in prospecting desirable/undesirable futures – by proxy of the individual's information search behaviour -, and is hence appropriate to our study. Other than Maytorena et al. (2007) and Winch and Maytorena's (2009) study, our experimental setting uses a computer-aided approach, in which the participant can browse a graphical interface to acquire information, and report the risks or opportunities identified in their prospected scenarios. We opted for the computer-based approach to facilitate data collection and reduce bias through the experimenter.

The experiment followed an inter-subject design, assigning participants to one of the two treatments labelled 'Risk' or 'Opportunity'. Participants in each group had to explore the same simulated project scenario. Depending on their group, they were asked to identify events or conditions that may have a negative (risks) or positive (opportunities) effect on project outcomes. 19 participants were part of the 'Risk' group, and 23 of the 'Opportunity' group.

The scenario used in the experiment was based on insights gathered through six problem-centric interviews (Witzel and Reiter, 2012) with individuals from the target population (not part of the sample). The interviews revealed the heterogeneity of a) desirable outcomes (e.g. grades, work atmosphere, 'learning something useful'), and b) the contextual factors that were perceived as creating risks or opportunities for these outcomes. For example, the participation of an exchange student was sometimes perceived as a risk to work atmosphere, as their expected lower participation could create tensions in the group. Or, working with a company during the project was sometimes seen as an opportunity for learning more about professional practice and building up contacts, thus creating personally beneficial outcomes. We organized these factors as 58 cues in three categories, which formed the scenario information that participants could browse throughout the experiment (see Appendix A). The design and set-up was tested with ten individuals from the target population (not part of the sample) to ensure comprehensibility, completeness, and technical functionality.

In the experiment, the participants interacted on a computer with a graphical interface, seated in a controlled laboratory environment. The participants could freely browse cues through topical buttons, organized by categories. Furthermore, the interface allowed participants to make notes in a text field, and to enter the identified risks or opportunities through an input mask. Participants could review and edit risks or opportunities anytime during the experiment. All interaction with the interface was recorded.

The experiment was preceded by a short trial-phase, using an unrelated scenario for familiarization with the interface. The experiment itself was limited to 12 min, indicated by a clock on screen. The time limitation created an indirect constraint for information availability, thereby simulating the typical incompleteness of information in project practice, and the need to focus the information search. The time-limit was established throughout the piloting of the experiment as suitable for creating time pressure while still allowing for reflection. The experiment was followed by a short post-experimental interview (7–12 min; see Appendix D). Appendix A provides an overview of the collected data; Appendix B explicates further details of the experimental setup.

3.3. Quantitative step: operationalization of information search behaviour

Following our abductive approach, we developed a measure for information search behaviour through several iterations between the data and the literature in cognitive psychology on search behaviour (Hills et al., 2015) and problem solving (Novick and Bassok, 2005). These bodies of literature suggest shifts in information search patterns, depending on the cognitive processes in play – e.g. for the exploration/exploitation dichotomy (Hills et al., 2015), or contrasting information processing (Kaplan and Simon, 1990; Mumford et al., 1994) and insight-seeking approaches (Helie and Sun, 2010; Luchins, 1942) for problem solving. We found distinct patterns of information search with regards to how strongly an individual followed the sequence of information presentation in their acquisition of new information. Thus, we used the sequence of external information acquisition, i.e. the order of cues accessed, as observable indicator for the external search behaviour. To quantify *search behaviour*, we thus introduced *Sequentiality* as measure.

We assumed that information acquisition that widely followed the presentation order ('*strong sequentiality*'), i.e. clicking the buttons in sequence of their presentation in the interface (Fig. 1, left), indicates the absence of a preconceived idea on which information is pertinent to the task. Thus, information gathering follows convenience rather than planning. Conversely, we assumed that a strong deviation from the presentation sequence ('*weak sequentiality*'), both in order and in direction, indicated concrete ideas on where to find relevant information. Appendix C provides a detailed description of the sequentiality measure.

3.4. Qualitative analysis of information search behaviour

The second step was a short, structured post-experimental interview to investigate the participants thought process when identifying risks/opportunities. The qualitative data analysis added depth to the characteristics of the information search behaviour by providing insights on their use of concrete autobiographic details (de Vito et al., 2015). Moreover, it revealed explicit strategies that the participants employed for constructing a concrete project future, and gave insights on their experience of the task. The statements concerning strategies and reasoning from the interviews were furthermore triangulated with the recorded behaviour throughout the experiment, in particular the reported risks or opportunities and the topical sequence of retrieved information.

The qualitative analysis followed the inductive 'Gioia'-method (Gioia et al., 2013) through which we iteratively connected informant-centric 1st order concepts, with theory-centric 2nd order themes that we aggregated into three dimensions. For the analysis, we first created individual case vignettes for each of the participants. We focussed the analysis on categories that related to statements and observations that revealed how participants perceived the task, strategies in how they approached the task, and characteristics of their reported risks/opportunities. We iterated the emerging 1st order concepts through a pragmatic prospection theory lens. Moreover, we also reflected on findings from a re-analysis of raw data graciously provided by Maytorena and Winch (2007; 2009) from their earlier AIS study (findings not published). This step produced seven 2nd order themes that we further aggregated into three dimensions (see Fig. 2 - Data structure). The first

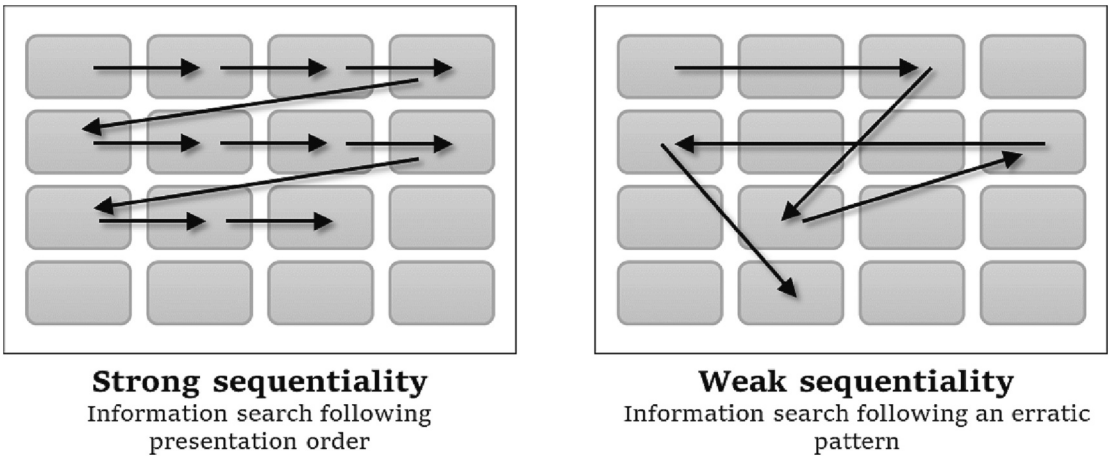

Fig. 1. Extreme cases of information search behaviour, operationalized as sequentiality of information acquisition (related to information presentation).

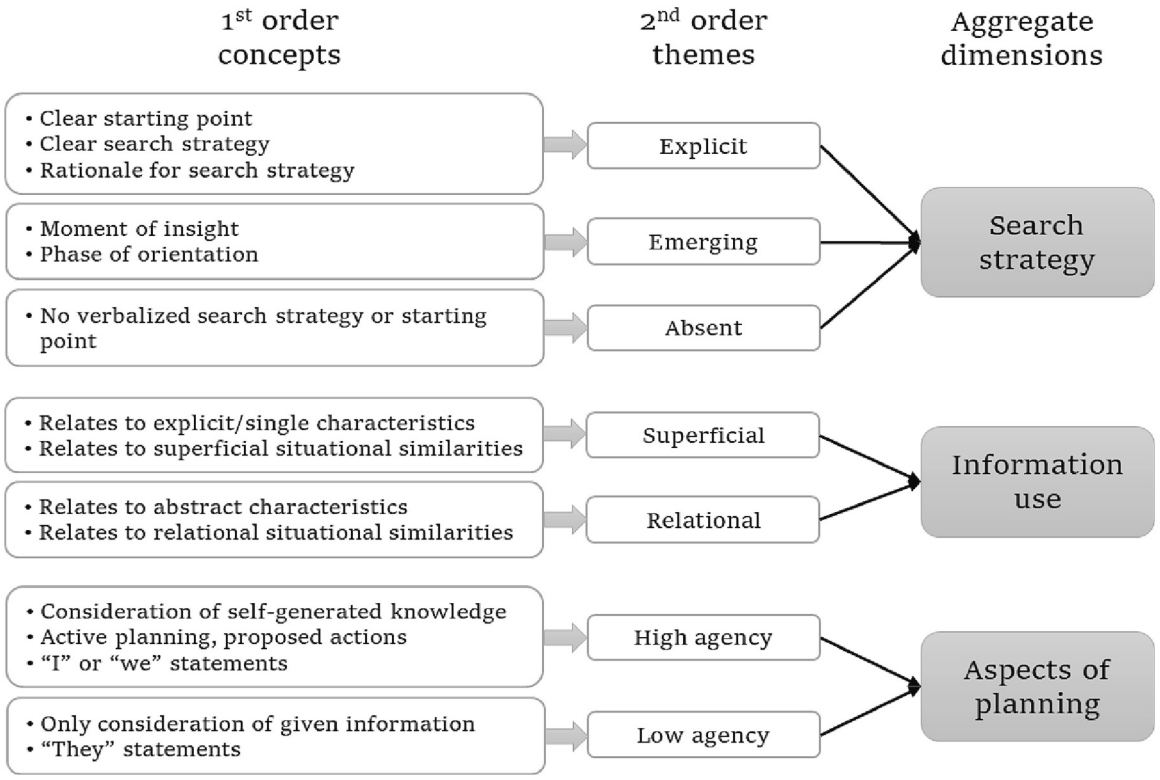

Fig. 2. Data structure.

author developed based on the resulting data structure a coding scheme (see Appendix E) that the second author applied to code a sample of the data to ensure a high level of inter-coder alignment. The 2nd order themes within the aggregate dimensions allowed further to explore differences in information search behaviour between the individuals in the opportunity or the risk group, to further theorize on the differences in the applied cognitive processes.

4. Results

The data suggests that the prospection of desirable and undesirable futures, and the identification of concrete risks and opportunities within these scenarios, induces significantly different information search behaviour. Specifically, we found tendencies towards stronger sequentiality of the information search in risk identification (convenience-based information search) and towards weaker sequentiality in opportunity identification (deliberate information search). The subsequent qualitative analysis explored the differences in cognitive processes. We found that participants in the Opportunity group were generally more able to verbalize their information search strategy, engaged more often in planning aspects related to the situation, and some individuals integrated acquired information in a manner that was more complex and relational manner than the participants in the Risk group. Overall, the individuals in the Opportunity group were more engaged in constructing rich future scenarios, whereas the individuals in the Risk group tended to identify and explicate risks without prior construction of concrete future scenarios.

4.1. Sequentiality in information search

We found that the Risk group had a higher tendency to follow the presentation sequence than the Opportunity group. A Wilcoxon signed-rank test indicated that the average proximity score of the Risk group was significantly lower than for the Opportunity group ($W = 322.5$, $p = 0.009$). Similarly, a Wilcoxon signed-rank test indicated that the average variance of proximity in the Risk group is lower than in the Opportunity group ($W = 337$, $p = 0.002$).

The right tail of the distribution drives this difference (see Fig. 3 and Fig. 4): only 15.8 % of the Risk group have an average proximity score of greater 0.75, compared to 52.2 % of the Opportunity group, and no individual of the Risk group has a proximity score exceeding 1.0, compared to 21.7 % of the Opportunity group. We found a similar tendency for variance, whereas 42.1 % of the Risk group had a proximity score variance of greater 1.0 compared to 69.6 % in the Opportunity group, and none of the Risk group had a proximity score variance greater 1.25 compared to 39.1 % of the Opportunity group.

We thus confirm our assumption, that the identification of risks v. opportunities engages different search behaviour therefore indicating different underlying cognitive processes. To explore how these differences in information search behaviour manifest, we turned to a qualitative analysis of the data.

4.2. Information search strategy

Through the juxtaposition of post-experimental interviews and information search behaviour in the experiment, we could identify three types of search strategies that were used at different frequencies in the Opportunity and Risk group: deliberate, emerging, and passive (Table 2).

4.2.1. Deliberate search strategies

We found that individuals in the Opportunity group tended to use emergent or deliberate search strategies, and were overall better able to verbalize and justify their search approach than the individuals in the Risk group. All of the participants in the Opportunity group justified what information they looked for and why, when asked about their information search strategy, with 10 of 23 of them expressing a deliberate search strategy consistent with their observed behaviour. Among those that did not start with a deliberate strategy, some expressed uneasiness regarding the lack of initial strategy. For example, one of them answered to the question whether she had followed a strategy: '*Frankly not. I would have liked to have had a strategy but basically I started looking at the general stuff.*' Conversely, within the Risk group, only three individuals were able to verbalize a *deliberate strategy* that was consistent with the observed information search behaviour.

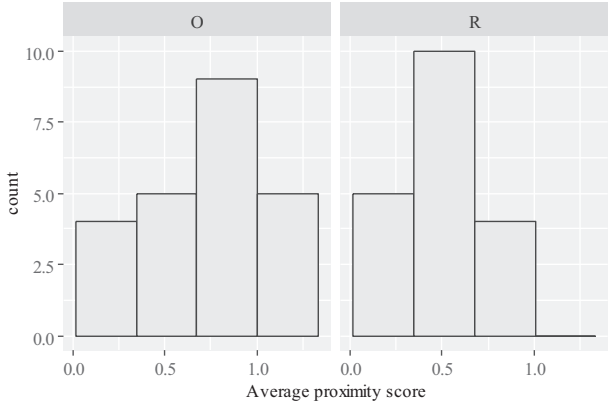

Fig. 3. Histogram of average proximity score by treatment.
O - Opportunity group; R - Risk group.

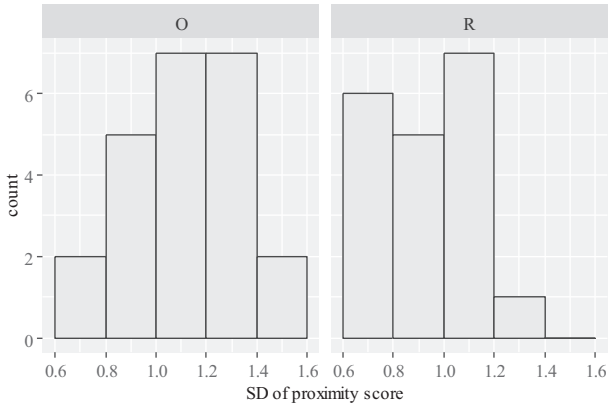

Fig. 4. Histogram of variance (as standard deviation) of proximity score by treatment.
O - Opportunity group; R - Risk group.

Table 2
Frequency count of different information search strategies (coded per individual).

	Risk ($N = 19$)	Opportunity ($N = 23$)
Passive	9 (47 %)	0 (0 %)
Emergent	7 (37 %)	13 (57 %)
Deliberate	3 (16 %)	10 (43 %)

Both Risk and Opportunity groups relied on similar types of *deliberate strategies*. The first strategy was guided by a desired/undesired outcome, that is, the search for information aimed to construct opportunities/risks that would create a desired/undesired outcome, e.g. '*I was mainly looking for things where people would [get in] conflict*'. The second strategy was to search for specific and known desirable/undesirable conditions. In the Risk group, this strategy was manifested in the use of a deductive strategy to check for a particular type of risk, such as mismatch between the team member's skills and the skills needed to complete the project. In the Opportunity group, participants looked particularly for aspects that they had potential to *act* on, as the following report illustrates: '*The group assignment is set; there is nothing you can do about that so there is no need to worry about it that much. [..] But I think it's the members and how they approach a group work and how they work together and how they contribute and supplement each other that's key for a project.*' Later he specified: '*I think there are certain elements in this where you want diversity [in group members]. And then there are some elements where you don't want diversity [..] you also want the right level of diversity.*' The third strategy, present only in the Opportunity group, was to use a guiding idea to create opportunities. Most often participants pursued the idea of task division to increase efficiency and quality, and searched for information useful to plan the division of the task among the group members.

4.2.2. Passive search strategy

Contrary to the deliberate search strategies most prevalent in the Opportunity group, nearly half of participants of the Risk group were not able to formulate what guided their search, other than following the presentation of information. These individuals would state that they were 'browsing' or 'trying to find what can be relevant' – rather than stating specific information areas that were of relevance to them. Others were able to recall the order in which they searched through the information but could not give a specific rationale for their search focus. These individuals did not express discomfort with the absence of a more deductive information search strategy, nor post-rationalized their search behaviour. Many of them stressed explicitly that they were following the information presentation, using statements such as '*I went through [the information] chronologically*' or '*I just started with the exact order of the*

icons. [..] I just kept on browsing.' Yet, despite a passive search strategy, these individuals were able to identify and report risks in similar numbers as the rest of the Risk group. They did so, not by actively searching and integrating information, but by recognizing and reacting to specific cues. For example, one participant stated '*I was going in order [of the information] basically, [..] I didn't know what's coming I was just going right away and wrote the first risk that came into my mind*'. Another reported, "*I read that and this made me think 'oh yeah, in this group we had this situation'!*"

4.2.3. Emergent search strategies

13 individuals of the Opportunity group and seven of the Risk group were classified as *emerging strategy*, characterised by two types of behaviour. First, some of these individuals, most notably in the Risk group, were able to justify the focus of their information search. However, their described strategy was not consistent with the observed search sequence in the experiment. This inconsistency indicated a post-rationalization of search strategies that these participants did not consciously experience.

In the Opportunity group, in contrast, we noted emerging strategies not only in the post-rationalization, but also denoting a change in the search strategy during the experiment. For example, one participant of the Opportunity group made the following clear strategy verbalization '*The most important thing is that we have to divide the task between ourselves, so I looked at people's weaknesses and strengths, their background and how busy they are.*' However, this participant only looked during the final minutes of the experiment into these particular parts of the information, indicating that the verbalized strategy only *emerged* throughout the task. Similarly, several participants described moments of insight, which helped them restructure how they approached the task. For example, a participant in the Opportunity group stated '*At the beginning I didn't quite know where to begin so I started at the very top, but then I decided to go more for: What are their ambitions? What do they actually expect from this?*'

Overall, we found that individuals in the Opportunity group tended towards more reflective and deliberate information search strategies when approaching the opportunity identification task. They relied more on deliberate strategic schemas to search for and categorize the available information, and deduct potential opportunities. Contrarily, individuals in the Risk group were more at ease with the absence of a deliberate information search strategy, collecting information rather through convenience than targeted search, and identifying risks through recognition, rather than deduction. This particular latter pattern becomes even more visible when we compare how the participants formulated risks and opportunities.

4.3. Structural differences in identified risks and opportunities

The task of identifying risks and opportunities yields a plethora of different solutions, even for the relatively narrowly defined scenario of our experiment. Exploring structural similarities and differences between the identified risks and opportunities allowed pinpointing to underlying cognitive processes applied by the individuals. These differences related to how much the individual actively constructed a full picture of a future scenario from which they then verbalized concrete risks and opportunities. In particular, we identified two types of tendencies in the data: how the identified risks/opportunities incorporated acquired information (superficial/relational), and whether the identified opportunity/risk involved agency or the participant (high/low). We observed that both Opportunity and Risk groups displayed a tendency for superficial engagement with the data, with Opportunity group showing a slightly higher tendency for relational information use than the Risk group (36 % and 19 %, respectively). In contrast, agency was clearly more present in the identified opportunities (73 %) than in the identified risks (15 %). Table 3 provides an overview of number of identified risks v. opportunities in each category.

Table 3
Frequency count for structural dimensions of recorded risks/opportunities (coded per recorded risk/opportunity).

	Risk ($N = 89$)	Opportunity ($N = 106$)
Superficial Information Use	72 (81 %)	68 (64 %)
Relational Information Use	17 (19 %)	38 (36 %)
High Agency	13 (15 %)	77 (73 %)
Low Agency	76 (85 %)	29 (27 %)

4.3.1. Information use – superficial and relational use of information

We found that externally acquired information could be reflected in two modes in the identified risks/opportunities. On the one hand, as superficial characteristics of the scenario, which participants recognized as a source of risks or opportunities (*superficial information use*). On the other hand, through the relationships between various characteristics of the scenario, which allowed the identification of risks and opportunities through analogical reasoning (*relational information use*; Holyoak and Thagard, 1997). Overall, we saw that both the Risk and the Opportunity group relied predominately on superficial information use (81 % of the recorded risks, and 64 % of the recorded opportunities), with a few individuals that relied substantially stronger on relational information use.

Superficial information use refers to risks and opportunities that have a simple cause/effect schema, with an explicit characteristic of the situation causing a risk or opportunity as effect. These characteristics were either specific details of the scenario (e.g. 'group is pre-assigned', 'C is an exchange student'), or aggregated cues specific to the scenario (e.g. 'different study backgrounds', 'different expectations'). The identified risks and opportunities are here disengaged from a concrete construction of a plausible project future.

Relational information use refers to risks or opportunities based on the relationships between specific cues or between cues and assumptions made about the situation. Typical relationships between cues were matches/mismatches between skills and requirements, or how weaknesses and strengths complemented each other. Thus, the participant constructed concrete novel future scenarios based on the available information. For example, a member in the Opportunity group noted '*B. probably has better organizational skills [to take the project management lead] but he might come off as too strict. A. will assist since she can help make things more fun.*' Related to mismatched skills and requirements, a member of the Risk group reported: '*Most of the group members are either shy or don't like presentation. Since 20% of the grade is presentation and every group member should present, it might get difficult for the group during the presentation.*'

4.3.2. Agency in the formulation of risk and opportunity identification

While the participants in the Risk and Opportunity group did not differ strongly in how they used the externally acquired information, we observed a strong difference when it came to whether agency was ascribed in the identified risk and opportunity. High agency meant that the assessor proposes actions to shape the future, that is, they constructed a specific future scenario based on what they (or the group in the simulation) *could do* in the future. Low agency meant that the assessor acts as a disengaged observer, merely pointing to risks/opportunities, but not considering mitigating/exploitative strategies. Whereas 73 % of the recorded opportunities displayed high agency in their formulation, only 15 % of the risks did.

5. Discussion

Our research was interested in characterising the differences between cognitive processes engaged in the prospection of desirable or undesirable project futures. Our research design intended to observe these processes in the context of a common project activity, the verbalisation of concrete risks and opportunities identified within the

prospected futures. While the findings indeed reveal marked differences between individuals identifying risks and those identifying opportunities, the most interesting observation was the lack of actual prospecting – or construction of future scenarios – for many of the participants, in particular within the 'Risk'-group. We will discuss in the following the implications of these findings for theory – in project studies and cognitive psychology – and project risk management practice.

5.1. Implications for theory

Our findings add to the theoretical foundations of cognitive studies in projects and other domains that are concerned with enacting the future through plans. We have introduced an alternative theoretical perspective on studying and conceptualizing how people in projects think about the future, based on their basal cognitive processes. Our perspective provided a fresh view on cognition in projects expanding previous research that was mainly concerned with assumptions of biased human minds (Stingl and Geraldi, 2017).

We extend the cognitive view of projects to a more complex and nuanced phenomenon allowing for a notion of a non-probabilistic future, grounded in a view of projects as state of mind and based on more recent understandings of prospection coming from cognitive psychology. We thereby allow investigating cognition even if we consider projects as uncertain and social-dynamic systems (Geraldi et al., 2011; Kreiner, 1995; van Marrewijk et al., 2016).

Specifically, by highlighting that 'thinking is for doing' (Baumeister et al., 2016), we argue that prospection is more than just a (biased) cue-giver for decision-making, but is fundamental to behaviour that shapes projects. Thus, our work provides a puzzle piece re-connecting works focussed on wider, organizational questions of sensemaking with its cognitive origins (Sandberg and Tsoukas, 2015), and connects the macro-processes described in project studies on future perfect thinking (Pitsis et al., 2003) with basal cognitive processes in project prospecting.

Contributing to theory in cognitive science, our findings suggest – in accordance with cognitive psychology literature (Baumeister et al., 2001; de Vito et al., 2015)– that when people think about the future in terms of risks, i.e. undesirable futures, they are often reflecting the emotions and experience of the past and present. Yet, other than suggested by pragmatic prospection theory, the risk-identifying individual does not (necessarily) actively construct a desirable future first, and thereafter screens for challenges and obstacles on the way. Rather, they appear often to merely screen the information landscape for cues that act as singular 'risk markers'. This use of singular cues to conclude on risks functions akin to the 'recognition heuristic' (Gigerenzer and Goldstein, 1996). This interpretation is supported by our findings that risk identification was generally perceived as a cognitively simpler task in which individuals were at ease with a non-rationalized information search strategy. Recognition heuristics are intuitive cognitive processes of the human mind (Gigerenzer and Selten, 2002), which means they are applied with ease, reducing cognitive load, and often without conscious selection as judgement strategy. Hence, for many of the individuals in the risk identification task, we did not observe behaviour that would constitute 'pragmatic prospection', but rather simple categorization whether a characteristic of the scenario could lead to undesired outcomes. This reliance on simple heuristics for categorization, rather than the construction of rich future scenarios allows offers an explanation for the contrasting findings of a study by de Vito et al. (2015), who found that participants experienced more difficulties in the construction of undesirable futures. However, in the case of our study, participants tasked to identify risks often did not engage in the prospection of an undesirable future.

On the other hand, we found that individuals searching for opportunities often developed conscious information search strategies, using active construction of the future including reflection of their own potential actions. Moreover, they were more likely to express specific schemas against which they reflected externally acquired information, rather than merely reacting directly to the information. This differentiation of opportunity search as active construction of the future, using relational schemata, versus risk search as affective reaction to the present are just general tendencies expressed as ideal types. Individuals are likely to engage in either strategy, as we have observed in some individuals that exhibited both approaches or shifted from one to the other. Effectively, the construction of a 'matrix of maybes' and the recognition of risk markers – or even opportunity markers – is likely to be an entangled process (cf. a similar argument for entrepreneurial cognition brought forward by Grégoire, 2014). Affective reaction, i.e. cues derived from automatic emotional responses, may serve as heuristics to create boundaries for imagined possible futures as they help individuals understand their current situation and potential future scenarios. Strong affective reactions to those markers may indeed constitute the 'invariants' of a situation, which Kaplan and Simon (1990) suggested as signpost in the mental search for an alternative problem representation. On the other hand, imagining the future, whether consciously or pre-consciously, enables to 'pre-feel' (Gilbert and Wilson, 2007) this future, thus affectively reacting to cues in this constructed future.

5.2. Implications for project practice

These findings bear implications for the practice of project risk and opportunity management (PROM) and similar organizational practices. Academic authors such as Hillson (2002) have lamented the lacking integration of opportunity management in existing risk management practices. Similarly, the works of Chapman and Ward (2011, 2003) stress the benefit of an integrated risk and opportunity management. In consequence, tools and methods used in practice for PROM usually integrate potential positive or negative plan deviations in a unified approach for their identification, assessment, and management (Chapman and Ward, 2003). However, our findings challenge the presumed benefits of such an integrative approach.

First, we provided an additional explanation for challenges in identifying and exploiting opportunities. Opportunity management is still experienced as a challenge and rarely used in projects (Hietajärvi et al., 2017). If people engage different cognitive processes when thinking about positive or negative future uncertainties, as our findings indicate, then the common method of forcefully considering both risks and opportunities together may suppress one way of thinking in favour of another. As risks have been perceived to be easier to identify than opportunities, and minds tends to choose cognitively less demanding modes of operation (Kahneman and Klein, 2009), opportunities might become overshadowed by the task of identifying risks. As a consequence, the identification of risks and opportunities would benefit from differentiated treatment, for instance through identifying them sequentially instead of concomitantly in a workshop.

Second, as many individuals considered cues for risk identification in the order they were displayed, visual design of information can have a significant influence on prospection. Our results adds to the bourgeoning empirical evidence that visualization impacts cognitive processes in projects (Comi and Whyte, 2018; Killen, 2013; Whyte et al., 2008) and beyond (Bell et al., 2014). However, despite recognition of its relevance, visualizations remain understudied. We therefore need to dedicate more attention both in research and in practice to the visualization of project information and its impact on how individuals imagine possible futures. The display of uncertainty is a widely recognized academic area, yet it has been mostly concerned with quantitative information, and more specifically, the display of probabilities to wide audiences (Spiegelhalter et al., 2011). However, there is a need for increased awareness of the visual dimension of organizing (Meyer et al., 2013), which is different from the visualizations used in natural sciences. Our research reinforces this call. We therefore suggest that the visual dimension of uncertainty in organizations provides a fertile domain for future applied and conceptual research.

Third, our observation provides an explanation based in cognitive sciences for what has been described in the project risk management literature as a 'tick-the-box' approach for risk management, in which the risk register is treated like a clerical task (Kutsch and Hall, 2010). As the results suggest, risk identification happens widely through recognition of 'risk markers'. Feeding to this intuitive strategy for risk identification, risk registers tend to be lists of disconnected risks without active construction of mental images of the future. Such simplified cognitive processes to risk identification would therefore undermine preparedness and the ability to sense weak signals (Weick and Sutcliffe, 2006). Yet, if we consider project management as an 'agency for uncertainty management' (Turner and Müller, 2003), risk management *is* project management (Loch et al., 2006). In this view, the observed superficial engagement with 'risk markers' in risk identification may lead to critical oversights. This implies that we need to pay attention whether common practices of managing uncertainty rather obfuscate practitioner's ability to identify risks through active construction of plausible futures, by implicitly encouraging them to screen merely for risk markers disconnected from concrete prospections.

An approach to enrich risk identification with constructions of possible futures is to integrate project planning and uncertainty management as a single process, unlike the current practice that sees planning and risk management as two separate processes that only share a few specified interfaces (Dvir and Lechler, 2004). Such change would require more than adjustments to the risk and opportunity identification processes. It would instead require considering uncertainty in project planning, building not one plan but alternative scenarios, and thereby treating uncertainty as seriously and integrative to project management as other core aspects of project planning, like tasks, time and budget.

Thus, implications to practice range from alterations in the process and tools used in identification processes to fundamental change in project management practice, that foster alternative, and arguably, more beneficial cognitive processes to help project managers envision the future.

5.3. Limitations and outlook for future research

As an abductive and in some ways exploratory study of complex processes of human cognition, this research has several limitations that invite for future research. On a general level, these limitations concern the, while quasi-realistic, nonetheless artificial setting of the experiment. In particular, the screen-based experimental design – while reducing the bias through the experimenter – may have an effect on behaviour and cognition. A comparative interview-based study would allow investigating this potential effect. Moreover, as shown earlier by Maytorena et al. (2007), formal risk management education (albeit not experience) has an influence on information search strategies in risk identification. Thus, practitioners that are trained in risk identification potentially will exhibit different tendencies in their cognitive processes, which would provide a fruitful opportunity for further research. Nevertheless, the research with students both yielded a categorization for the investigation of such strategies, and provided a glimpse into intuitive strategies that the human mind applies when thinking about the future. Besides exploring the effect of experience or training, research might also explore the effects of personality traits such as creativity or risk aversion in their effect on prevalent cognitive processes for prospecting. These identified tendencies thus contribute to academia and practice as outline before.

Moreover, by attending to the specifics of individual cognition, our insights also provide a means to connect between collective processes of "prospective sensemaking" (Sandberg and Tsoukas, 2015) and the individual level. Specifically we see interesting opportunities for research when searching for similarities or differences between the cognitive strategies used by individuals pertaining to the same group (e.g. project team), and shifts in strategies when co-exploring plausible futures.

Throughout the analysis, we identified additional potentially interesting types of data that were not collected through the original experimental design but are common to contemporary research in cognitive sciences. Specifically, we did not collect data on physiological and neurological responses – i.e. psychophysiological data (Cacioppo et al., 2017) – that could add depth to understanding how and when individuals respond to newly acquired information. Future studies could also collect qualitative data concerning the verbalization throughout the experiment as think-aloud protocol, or check-up questions regarding a search strategy throughout the risk/opportunity identification process. However, any such interventions are likely to influence the cognitive processes, through forcing a reflective engagement with potentially preconscious processes.

Regarding the generalization of the findings, the choice of the sample and the artificial setting of the experiment pose relevant limitations. Specifically the chosen university project scenario differs significantly from large-scale industry projects. In industry projects, uncertainty is amplified, and agency potentially limited due to the number of involved actors. Moreover, in such projects, information is presented through a variety of modes, and the costs of information acquisition (regarding time, effort, and money) are highly varied. Such differences can trigger the development of alternative and sector specific cognitive processes for the identification of risks and opportunities, that could be explored in future research. Such specific cognitive processes would extend the basal intuitive processes that we aimed to identify in this study. Yet, our findings provide a basis for the formulation of specific hypotheses that future research may explore in those more dynamic and complex project environments. In particular, such research could investigate the effect of specific information presentation or typically used risk management methods on the prevalent cognitive processes. Additionally, future research of a similar design but a sample of practitioners with more exposure to professional project or risk management, could investigate the effect of such exposure on the cognitive process that would characterise experts in risk and opportunity identification. Another research avenue is to observe risk and opportunity identification in situ, and inquire into the cognitive processes of trained project professionals in their natural setting, and contrast them with our results. Following the naturalistic decision making tradition (Klein, 2015), such studies could explore the cognitive processes of experienced practitioners who are considered to be outstanding in dealing with uncertainty in projects.

In summary, our research highlights the importance of further studies exploring the cognition of those individuals shaping and executing plans, in other words: the micro-side of organizing for the future. Project studies, as an example of this context, have been mostly concerned with the study of organizations on the meso- or macro-levels (Geraldi and Söderlund, 2018). Yet, in the spirit of seeing risks and opportunities as a 'state-of-mind', and acknowledging the practical implications of prospection on planning and acting, we have shown that thinking about the future is a more complicated phenomenon than merely biased minds. We suggest therefore that future research pays more attention to how the individual forms their perceptions and assumptions of the future and how these perception relate to their behaviour as actors in plans to shape the future.

6. Conclusion

With this study, we sought to uncover the cognitive processes through which the human mind prospects desirable and undesirable project futures. Grounded in the literature of pragmatic prospection (Baumeister et al., 2016), we have shown that the human mind has a repertoire of different cognitive processes to search for uncertainties in the future. Some are more passive and reactive to visualization and past experiences, are done with ease, and are most commonly used in the identification of risks. Others trigger active future construction and are cognitively more laborious, which we observed predominantly in the identification of opportunities. The differences in cognitive processes provide a fundament for further research that, in the long run, can

augment project practitioners' ability to cognitively engage with and manage an uncertain future. We also point to potential adverse effects of current risk management in practice.

Thus, despite the common framing in the academic and practitioner literature that risks and opportunities are merely 'two sides of the same coin', we showed that individuals think differently, when engaging with desirable and undesirable futures. Future research and practice would benefit from understanding cognitive processes, and applying them more strategically and deliberately in project practice and other domains of risk management. Our research therefore suggests that it is essential to embrace human cognition as a lens to study how people in organizations engage with, and navigate uncertainty, when devising and implementing plans and projects.

CRediT authorship contribution statement

Verena Stingl: Conceptualization, Methodology, Investigation, Analysis, Writing – Original Draft, Review & Editing; Joana Geraldi: Conceptualization, Analysis, Writing – Review & Editing.

Acknowledgement & Funding

Parts of this research were funded through ABB Ltd. through the funding of the first authors PhD fellowship. Funds for participation compensation were received through the Brightline Initiative.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.techfore.2023.122701.

References

Atance, Cristina M., O'Neill, Daniela K., 2001. Episodic future thinking. Trends Cogn. Sci. 5 (12), 533–539. https://doi.org/10.1016/S1364-6613(00)01804-0.
Aven, Terje, Renn, Ortwin, 2009. On risk defined as an event where the outcome is uncertain. J. Risk Res. 12 (1), 1–11. https://doi.org/10.1080/13669870802488883.
Baumeister, Roy F., Bratslavsky, Ellen, Finkenauer, Catrin, Vohs, Kathleen D., 2001. Bad is stronger than good. Rev. Gen. Psychol. 5 (4), 323–370. https://doi.org/10.1037//1089-2680.5.4.323.
Baumeister, Roy F., Vohs, Kathleen D., Oettingen, Gabriele, 2016. Pragmatic prospection: how and why people think about the future. Rev. Gen. Psychol. 20 (1), 3–16. https://doi.org/10.1037/gpr0000060.
Baumeister, Roy F., Maranges, Heather M., Sjåstad, Hallgeir, 2018. Consciousness of the future as a matrix of maybe: pragmatic prospection and the simulation of alternative possibilities. Psychol. Conscious. Theory Res. Pract. 5 (3), 223–238. https://doi.org/10.1037/cns0000154.
Bell, Emma, Warren, Samantha, Schroeder, Jonathan E., 2014. The Routledge Companion to Visual Organization. Routledge.
Berander, P., 2004. Using students as subjects in requirements prioritization. In: Proceedings. 2004 International Symposium on Empirical Software Engineering, 2004. ISESE '04, pp. 167–176.
Cacioppo, John T., Tassinary, Louis G., Berntson, Gary G. (Eds.), 2017. Handbook of Psychophysiology, 4th edition. Cambridge University Press, Cambridge, United Kingdom; New York, NY, USA.
Chapman, Chris, Ward, Stephen, 2003. Project Risk Management: Processes, Techniques and Insights, 2nd edition. John Wiley & Sons, Chichester.
Chapman, Chris, Ward, Stephen, 2011. How to Manage Project Opportunity and Risk (3rd Edition of "Project Risk Management: Processes, Insights and Techniques"). John Wiley & Sons.
Comi, Alice, Whyte, Jennifer, 2018. Future making and visual artefacts: an ethnographic study of a design project. Organ. Stud. 39 (8), 1055–1083.
Daniel, Pierre A., Daniel, Carole, 2018. Complexity, uncertainty and mental models: from a paradigm of regulation to a paradigm of emergence in project management. Int. J. Proj. Manag. 36 (1), 184–197. https://doi.org/10.1016/j.ijproman.2017.07.004.
de Vito, S., Neroni, M.A., Gamboz, N., Della Sala, S., Brandimonte, M.A., 2015. Desirable and undesirable future thoughts call for different scene construction processes. Q. J. Exp. Psychol. 68 (1), 75–82. https://doi.org/10.1080/17470218.2014.937448.
Djuricic, Ksenija, Bootz, Jean-Philippe, 2019. Effectuation and foresight – an exploratory study of the implicit links between the two concepts. Technol. Forecast. Soc. Chang. 140, 115–128. https://doi.org/10.1016/j.techfore.2018.04.010.
Druckman, James N., Kam, Cindy D., 2011. Students as experimental participants - a defense of the 'narrow data base.'. In: Cambridge Handbook of Experimental Political Science. Cambridge University Press, New York.
Dvir, Dov, Lechler, Thomas G., 2004. Plans are nothing, changing plans is everything: the impact of changes on project success. Res. Policy 33 (1), 1–15.
Engwall, Mats, 2003. No project is an island: linking projects to history and context. Res. Policy 32 (5), 789–808. https://doi.org/10.1016/S0048-7333(02)00088-4.
Flyvbjerg, Bent, 2008. Curbing optimism bias and strategic misrepresentation in planning: reference class forecasting in practice. Eur. Plan. Stud. 16 (1), 3–21. https://doi.org/10.1080/09654310701747936.
Geraldi, Joana, Söderlund, Jonas, 2018. Project studies: what it is, where it is going. Int. J. Proj. Manag. 36 (1), 55–70. https://doi.org/10.1016/j.ijproman.2017.06.004.
Geraldi, Joana, Maylor, Harvey, Williams, Terry, 2011. Now, lset's make it really complex (complicated). Int. J. Oper. Prod. Manag. 31 (9), 966–990. https://doi.org/10.1108/01443571111165848.
Gigerenzer, Gerd, Goldstein, Daniel G., 1996. Reasoning the fast and frugal way: models of bounded rationality. Psychol. Rev. 103 (4), 650–669. https://doi.org/10.1037/0033-295X.103.4.650.
Gigerenzer, Gerd, Selten, Reinhard, 2002. Bounded Rationality: The Adaptive Toolbox. MIT Press.
Gilbert, D.T., Wilson, T.D., 2007. Prospection: experiencing the future. Science 317 (5843), 1351–1354.
Gioia, Dennis A., Corley, Kevin G., Hamilton, Aimee L., 2013. Seeking qualitative rigor in inductive research: notes on the Gioia methodology. Organ. Res. Methods 16 (1), 15–31. https://doi.org/10.1177/1094428112452151.
Grégoire, Denis A., 2014. Exploring the affective and cognitive dynamics of entrepreneurship across time and planes of influence. In: Mitchell, J.R., Mitchell, R. K., Randolph-Seng, B. (Eds.), Handbook of Entrepreneurial Cognition2. Edward Elgar Publishing.
Haig, Brian D., 2005. An abductive theory of scientific method, 10 (4), 371–388. https://doi.org/10.1037/1082-989X.10.4.371.
Helie, Sébastien, Sun, Ron, 2010. Incubation, insight, and creative problem solving: a unified theory and a connectionist model. Psychol. Rev. 117 (3), 994.
Hietajärvi, Anna-Maija, Aaltonen, Kirsi, Haapasalo, Harri, 2017. Opportunity management in large projects: a case study of an infrastructure alliance project. Constr. Innov. 17 (3), 340–362. https://doi.org/10.1108/CI-10-2016-0051.
Hills, T.T., Todd, P.M., Lazer, D., Redish, A.D., Couzin, I.D., Cognitive Search Research Group, 2015. Exploration versus exploitation in space, mind, and society. Trends Cogn. Sci. 19 (1), 46–54.
Hillson, David, 2002. Extending the risk process to manage opportunities. Int. J. Proj. Manag. 20 (3), 235–240. https://doi.org/10.1016/S0263-7863(01)00074-6.
Holyoak, Keith J., Thagard, Paul, 1997. The analogical mind. Am. Psychol. https://doi.org/10.1037/0003-066X.52.1.35.
Huber, O., Wider, R., Huber, O.W., 1997. Active information search and complete information Preesentation in naturalistic risky decision tasks. Acta Psychol. 95, 15–29.
Huber, Oswald, Huber, Odilo W., Bär, Arlette S., 2011. Information search and mental representation in risky decision making: the advantages first principle. J. Behav. Dec. Making 24 (24), 223–248. https://doi.org/10.1002/bdm.674.
Kahneman, Daniel, Klein, Gary, 2009. Conditions for intuitive expertise: a failure to disagree. Am. Psychol. 64 (6), 515–526. https://doi.org/10.1037/a0016755.
Kahneman, Daniel, Tversky, Amos, 1979. Prospect theory: an analysis of decision under risk. Econometrica 66 (3), 497–527.
Kaplan, Craig A., Simon, Herbert A., 1990. In search of insight. Cogn. Psychol. https://doi.org/10.1016/0010-0285(90)90008-R.
Kappes, Heather Barry, Sharma, Eesha, Oettingen, Gabriele, 2013. Positive fantasies dampen charitable giving when many resources are demanded. J. Consum. Psychol. 23 (1), 128–135. https://doi.org/10.1016/j.jcps.2012.02.001.
Killen, Catherine P., 2013. Evaluation of project interdependency visualizations through decision scenario experimentation. Int. J. Proj. Manag. 31 (6), 804–816. https://doi.org/10.1016/j.ijproman.2012.09.005.
Klein, Gary, 2015. A naturalistic decision making perspective on studying intuitive decision making. J. Appl. Res. Mem. Cogn. 4 (3), 164–168. https://doi.org/10.1016/j.jarmac.2015.07.001.
Kreiner, Kristian, 1995. In search of relevance: project management in drifting environments. Scand. J. Manag. 11 (4), 335–346. https://doi.org/10.1016/0956-5221(95)00029-U.
Kreiner, Kristian, 2014. Restoring project success as phenomenon. In: Advancing Research on Projects and Temporary Organizations. Copenhagen Business School Press, pp. 19–38.
Kutsch, Elmar, Hall, Mark, 2010. Deliberate ignorance in project risk management. Int. J. Proj. Manag. 28 (3), 245–255. https://doi.org/10.1016/j.ijproman.2009.05.003.
Loch, Christoph, De Mayer, Arnoud, Pich, Michael T., 2006. Managing the Unkown: A New Approach to Managing High Uncertainty and Risks in Projects. John Wiley & Sons, Hoboken, New Jersey.
Lovallo, Dan, Kahneman, Daniel, 2003. Delusions of success: how optimism undermines executives' decisions. Harv. Bus. Rev. 81 (7), 56–63. https://doi.org/10.1225/R0307D.
Luchins, Abraham S., 1942. Mechanization in problem solving: the effect of Einstellung. Psychol. Monogr. https://doi.org/10.1037/h0093502.
Lundin, R.A., 2016. Project society: paths and challenges. Proj. Manag. J. 47 (4), 7–15.
Maytorena, E., Winch, G., Freeman, J., Kiely, T., 2007. The influence of experience and information search styles on project risk identification performance. IEEE Trans. Eng. Manag. 54 (2), 315–326. https://doi.org/10.1109/TEM.2007.893993.
Meyer, Werner G., 2014. The effect of optimism bias on the decision to terminate failing projects. Proj. Manag. J. 45 (4), 7–20. https://doi.org/10.1002/pmj.21435.

Meyer, Renate E., Höllerer, Markus A., Jancsary, Dennis, van Leeuwen, Theo, 2013. The visual dimension in organizing, organization, and organization research: core ideas, current developments, and promising avenues. Acad. Manag. Ann. 7 (1), 489–555. https://doi.org/10.5465/19416520.2013.781867.

Monroe, Andrew E., Ainsworth, Sarah E., Vohs, Kathleen D., Baumeister, Roy F., 2017. Fearing the future? Future-oriented thought produces aversion to risky investments, trust, and immorality. Soc. Cogn. 35 (1), 66–78. https://doi.org/10.1521/soco.2017.35.1.66.

Morris, P., Pinto, J., Söderlund, J., 2011. Introduction: researching the third wave of project management. In: Morris, P., Pinto, J., Söderlund, J. (Eds.), Oxford Handbook of Project Management. Oxford Univeristy Press.

Mumford, Michael D., Reiter-Palmon, Roni, Redmond, Matthew R., 1994. Problem construction and cognition: applying problem representations in Ill-defined domains. In: Problem Finding, Problem Solving, and Creativity.

Musca, Geneviève Neukirch, Mellet, Caroline, Simoni, Gilda, Sitri, Frédérique, de Vogüé, Sarah, 2014. 'Drop your boat!': the discursive co-construction of project renewal. The case of the Darwin mountaineering expedition in Patagonia. Int. J. Proj. Manag. 32 (7), 1157–1169. https://doi.org/10.1016/j.ijproman.2014.02.006.

Novick, Laura R., Bassok, Miriam, 2005. Problem solving. In: The Cambridge Handbook of Thinking and Reasoning.

Oettingen, Gabriele, 2012. Future thought and behaviour change. Eur. Rev. Soc. Psychol. 23 (1), 1–63. https://doi.org/10.1080/10463283.2011.643698.

Oettingen, Gabriele, Pak, Hyeon-ju, Schnetter, Karoline, 2001. Self-regulation of goal-setting: turning free fantasies about the future into binding goals. J. Pers. Soc. Psychol. 80 (5), 736–753. https://doi.org/10.1037/0022-3514.80.5.736.

Olsson, Rolf, 2007. In search of opportunity management: is the risk management process enough? Int. J. Proj. Manag. 25 (8), 745–752. https://doi.org/10.1016/j.ijproman.2007.03.005.

Peterson, Robert A., 2001. On the use of college students in social science research: insights from a second-order meta-analysis. J. Consum. Res. 28 (3), 450–461. https://doi.org/10.1086/323732.

Pinto, Jeffrey K., Patanakul, Peerasit, 2015. When narcissism drives project champions: a review and research agenda. Int. J. Proj. Manag. 33 (5), 1180–1190. https://doi.org/10.1016/j.ijproman.2015.01.013.

Pitsis, Tyrone S., Clegg, Stewart R., Marosszeky, Marton, Rura-Polley, Thekla, 2003. Constructing the olympic dream: a future perfect strategy of project management. Organ. Sci. 14 (5), 574–590. https://doi.org/10.1287/orsc.14.5.574.16762.

PMBOK Guide - Sixth Edition, 2017. Project Management Body of Knowledge.

PMI, 2019. The Standard for Risk Management in Portfolios. Programs and Projects, Project Management Institute.

Raz, Tzvi, Hillson, David, 2005. A comparative review of risk management standards. Risk Manag. 7 (4), 53–66. https://doi.org/10.1057/palgrave.rm.8240227.

Rowland, Nicholas J., Spaniol, Matthew J., 2015. The future multiple. Foresight 17 (6), 556–573. https://doi.org/10.1108/FS-02-2015-0014.

Sakellariou, E., Vecchiato, R., 2022. Foresight, sensemaking, and new product development: constructing meanings for the future. Technol. Forecast. Soc. Chang. 184 https://doi.org/10.1016/j.techfore.2022.121945.

Sandberg, Jörgen, Tsoukas, Haridimos, 2015. Making sense of the sensemaking perspective: its constituents, limitations, and opportunities for further development. J. Organ. Behav. 36 (S1), S6–32. https://doi.org/10.1002/job.1937.

Sanderson, Joe, 2012. Risk, uncertainty and governance in megaprojects: a critical discussion of alternative explanations. Int. J. Proj. Manag. 30 (4), 432–443. https://doi.org/10.1016/j.ijproman.2011.11.002.

Seligman, Martin E.P., Railton, Peter, Baumeister, Roy F., Sripada, Chandra, 2013. Navigating into the future or driven by the past. Perspect. Psychol. Sci. 8 (2), 119–141. https://doi.org/10.1177/1745691612474317.

Shepperd, James A., Klein, William M.P., Waters, Erika A., Weinstein, Neil D., 2013. Taking stock of unrealistic optimism. Perspect. Psychol. Sci. 8 (4), 395–411. https://doi.org/10.1177/1745691613485247.

Spiegelhalter, David, Pearson, Mike, Short, Ian, 2011. Visualizing uncertainty about the future. Science 333 (6048), 1393–1400. https://doi.org/10.1126/science.1191181.

Stingl, Verena, Geraldi, Joana, 2017. Errors, lies and misunderstandings: systematic review on behavioural decision making in projects. Int. J. Proj. Manag. 35 (2), 121–135. https://doi.org/10.1016/j.ijproman.2016.10.009.

Tetlock, Philip E., Gardner, Dan, 2016. Superforecasting: The Art and Science of Prediction. Random House.

Turner, J. Rodney, Müller, Ralf, 2003. On the nature of the project as a temporary organization. Int. J. Proj. Manag. 21 (1), 1–8. https://doi.org/10.1016/S0263-7863(02)00020-0.

Tversky, Amos, Kahneman, Daniel, 1974. Judgment under uncertainty: heuristics and biases. Science 185 (4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124.

van Marrewijk, Alfons, Ybema, Sierk, Smits, Karen, Clegg, Stewart, Pitsis, Tyrone, 2016. Clash of the titans: temporal organizing and collaborative dynamics in the Panama Canal megaproject. Organ. Stud. 37 (12), 1745–1769. https://doi.org/10.1177/0170840616655489.

Ward, Stephen, Chapman, Chris, 2003. Transforming project risk management into project uncertainty management. Int. J. Proj. Manag. 21 (2), 97–105. https://doi.org/10.1016/S0263-7863(01)00080-1.

Ward, Tony, Clack, Samuel, Haig, Brian D., 2018. The abductive theory of method: scientific inquiry and clinical practice, 33 (4), 212–231. https://doi.org/10.1017/bec.2017.1.

Weick, Karl, 1995. Sensemaking in Organizations. SAGE.

Weick, K.E., Sutcliffe, K.M., 2006. Mindfulness and the quality of organizational attention | organization science. Organ. Sci. 17 (4), 514–524.

Weinstein, Neil D., 1980. Unrealistic optimism about future life events. J. Pers. Soc. Psychol. 39 (5), 806–820. https://doi.org/10.1037/0022-3514.39.5.806.

Whyte, Jennifer, Ewenstein, Boris, Hales, Mike, Tidd, Joe, 2008. Visualizing knowledge in project-based work. Long Range Plan. 41 (1), 74–92. https://doi.org/10.1016/j.lrp.2007.10.006.

Willumsen, Pelle, Oehmen, Josef, Stingl, Verena, Geraldi, Joana, 2019. Value creation through project risk management. Int. J. Proj. Manag. 37 (5), 731–749. https://doi.org/10.1016/j.ijproman.2019.01.007.

Winch, Graham M., Maytorena, Eunice, 2009. Making good sense: assessing the quality of risky decision-making. Organ. Stud. 30 (2–3), 181–203. https://doi.org/10.1177/0170840608101476.

Winch, Graham M., Maytorena, Eunice, 2011. Managing Risk and Uncertainty on Projects: A Cognitive Approach Oxford Handbooks Online Managing Risk and Uncertainty on Projects: A Cognitive Approach, November 2018, pp. 1–23. https://doi.org/10.1093/oxfordhb/9780199563142.003.0015.

Witzel, Andreas, Reiter, Herwig, 2012. The Problem-Centered Interview. Sage.

Verena Stingl is Assistant Professor at Aalborg University, Denmark, at the Center for Industrial Production. She researches organisational behaviour and managerial cognition in uncertain projects and strategic transformations. She has a professional background as risk manager in a high-tech cooperation and as risk consultant for a Big-Four firm. She has published in peer reviewed journals and conferences, and in practitioner orientated handbooks mostly within the project studies community.

Joana Geraldi is Associate Professor at Copenhagen Business School. Her research focus is project-based organizations, in particular organization and behavioural decision-making and visualization. She has published contributions in peer reviewed journals, conferences and books, mostly within the project studies community.