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To cite this version:

Clément Colin, Antoine Martin. Improving mental time travel abilities to support the collection of needs: a pilot study. Future Work: Digitalisation and Innovation, Nordic Ergonomics and Human Factors Society, Aug 2019, Elsinore, Denmark. pp.86-93. hal-02348430

HAL Id: hal-02348430

https://hal.science/hal-02348430v1

Submitted on 5 Nov 2019

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Improving mental time travel abilities to support the collection of needs: a pilot study

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Abstract: Several branches stemming from the field of human-centered design have tackled the discovery of user needs in early design phases. Within one of these approaches, prospective ergonomics, this study is calling for new methods in order to better elicit needs from the user. The study draws from the research on future-oriented cognition regarding how people imagine the future. We then report on a pilot study on the effect of two future projection tasks on the elaboration of user needs.

Keywords: Prospective ergonomics, mental time travel, needs anticipation.

1. Introduction

For several years the field of human-centered design has been moving toward new approaches applied to the design of yet-unknown or ill-defined future products or services (McKim, 1972; Sterling, 2005; Hey, Linsey, Agogino, Wood, 2008; Robert and Brangier, 2009 etc.). One of these approach, prospective ergonomics, has been defined by Robert and Brangier as "the part of ergonomics that attempts to anticipate human needs and activities so as to create new artifacts that will be useful and provide a positive user experience". Some past and current projects in prospective ergonomics have dealt with the future of energy (Martin et al., 2018) mobilities (Brangier et al., 2018) and software (Nelson et al., 2018).

As of today, prospective ergonomics does not incorporate developments from cognitive psychology regarding the individual's ability to imagine a future. Since prospective ergonomics aims to anticipate future uses and needs it is then of the foremost importance to enable users and experts to better think, experience and verbalize probable futures in order to collect ideas and representations, build and explore scenarios. Thus, understanding how people project themselves into the future could be a stepping stone in order to develop new needs and uses anticipation methods.

The goal of the study is to assess the effect of two consecutive *future projection tasks* on the expression of future needs. Other independent variables were manipulated (they won't be reported in details in the paper): the topics (energy for housing and transportation), the collection tools (sentence completion tests vs. open-ended questions), system definition level (yet-unknown vs. ill-defined). We chose to vary the system definition level because it offers value for use cases in prospective ergonomics where practitioners are asked either to explore needs and uses related to ill-defined or to yet-unknown socio-technical systems.

2. Mental time travel

Back in 1781, Kant penned the concept of *anticipation* in his essay the Critique of Pure Reason ("All cognition, by means of which I am enabled to cognize and determine a priori what belongs to empirical cognition, may be called an anticipation.") and Bergson penned the concept of *élan vital* (1907) a kind of future-oriented spontaneity.

This ability to project oneself in the future has been termed *mental time travel* (Suddendorf and Corballis, 1997), *future thinking* (Atance and O'Neill, 2001), *envisioning the future* (Buckner and Carroll, 2007), *future-oriented cognition* (D'Argembeau et al., 2011; Osvath and Martin-Ordas, 2014) etc. According to Schacter et al. (2017), it is the ability to consider an experience by mentally creating a realistic scenario that combines image, thought and action; it is what allow us to anticipate future events (Eustache, 2018). Here we will use the term mental time travel defined by Doris Bischof-Köhler as the capacity to "represent oneself at every possible instant in the past and in the future and to imagine the desires and motives at each of those instants independently of one's present motivational state".

The central hypothesis of mental time travel (or MTT) is that the ability to imagine a future relies on memory systems. In 1985, Endel Tulving distinguished 2 types of memories linked to 2 types of anticipation: the anticipation of personal events (using the episodic memory) and the anticipation of general events (semantic memory) on the basis of patients (such as K.C.) with damaged episodic memory that were unable to imagine a personal future (the so-called *episodic foresight* ability) yet they were able to imagine a general future (Kwan et al., 2013). Using fMRI, Viard et al. (2011) confirmed that neuronal regions activated while envisioning the future are the same as those activated when proceeding to remembrance. Structures shared between episodic memory and future-oriented cognition have been identified as the hippocampus (Hassabis et al., 2007), the cingulate cortex, the prefrontal cortex and the precuneus (Viard et al., 2011). The contribution of semantic memory has been less studied but Irish et al. (2012) concluded that semantic dementia patients also had a reduced ability to episodic foresight. The root cause might be that there is no strict biological separation between semantic and episodic memory systems (Squire et al., 2004; Balota and Coane, 2008; Greenberg and Verfaellie, 2010).

Despite this growing literature, recommendations are rare regarding stimulation methods of the MTT ability. To describe these methods, we will use the umbrella term *future projection task* (Raffard et al., 2012; Bonn and Tafarodi, 2013)

3. Future projection tasks

Some researchers have started to propose ideas for the design of future projection tasks. D'Argembeau and Van der Linden (2012) underline that improving the quality of MTT is dependent on the specificity of the explored episode/situation and the quality of the sensory-contextual representation. Thus, Irish and Piguet (2013) recommend to follow two steps to project oneself in the future i) build an image of the event and its context, on the basis of memories and ii) develop and enrich the representations of the event.

For the study, two existing future projection tasks have been adapted to an online survey format. The tasks were used as *primers*, a common tool in the fuzzy front end of design projects (e.g. Nelson and Guegan, 2019). Cognitive priming is the use of stimuli to elicit specific ideation or mental processes.

The two future projection tasks are: the Guided Imaginary Projection (Allinc et al., 2018) and the Future Thinking Task (MacLeod et al., 1998).

Guided Imaginary Projection (GIP) is the mental, first-person exploration of a scenario related to a future service/product with the help of the design practitioner. Here the researcher's guidance

took the form of an audio recording instructing to relax and to imagine a specific situation with as much details as possible (Noël et al., 2017), then the respondent was asked to fill a form with a description of the situation he/she envisioned thus shifting the originally oral verbalization of the GIP to a text format.
The Future Thinking Task (FTT) is a kind of verbal fluency task where the participant is asked to name a number of future experiences that will happen to him at different times in the future (e.g. one week, one year, ten years), then he is tasked with evaluating the likelihood and valence of each event. For the sake of brevity, FTT was adapted in the following manner: the respondents were asked to list three experiences that could happen in their future.

4. Method

4.1 Participants

Participants were recruited through web communities with interests relative to the topics of the study (i.e. energy for housing and transportation). A total of 205 respondents were included for analysis (70 females, 129 males and 6 who did not specify their gender). They were between the age of 17 and 77 (mean = 43.6, standard deviation = 15.0). Among all participants 17 were excluded (4 for not answering the questionnaire, and 13 for failing to perform one of the future projection tasks).

4.2 Procedure

Participants were randomly assigned to a set of 16 different online surveys (see Table 1) using the "random redirector" code (Fergusson, 2017) with the independent variables being:

- Topic (energy for housing or transportation)
- System definition level (ill-defined or yet-unknown)
- Future projection tasks (with or without)
- Collection tool (open-ended questions or sentence completion test)

Table 1: Table summarizing the construction of the eight possible conditions that were applied to the two topics (energy for housing or transportation)

Ill-defined systems				Yet-unknown systems			
Without future projection tasks		With future projection tasks		Without future projection tasks		With future projection tasks	
Open-ended ques-tions	Sentence comple-tion test	Open-ended ques-tions	Sentence comple-tion test	Open-ended ques-tions	Sentence comple-tion test	Open-ended ques-tions	Sentence comple-tion test

First, participants were introduced to one of the two topics. Each topic was parted in two possible conditions: yet-unknown or ill-defined. (e.g. "This study aims to collect your thoughts on a possible future for the car. In this scenario, cars are mostly autonomous and shared." for the ill-defined condition and "This study aims to collect your thoughts on the future of the car." for the yet-unknown condition).
Then, depending on the modality, participants were either led to project themselves into the future using two consecutive future projection tasks (adapted from GIP and FTT, see 3.2) or went on to the next step without any projection task occurring. Future projection tasks were i) to listen to a

1-min audio recording asking the participant to imagine in as much detail as possible an experience with a future vehicle (or house) then to write it down, and ii) to list 3 things they think will happen to them in their future.
Finally, they had to answer either a sentence completion test (e.g. "In the future, using a car, I will feel safe if ...") or an equivalent open-ended questionnaire (e.g. "In the future, when you will use a car, what would make you feel safe?"). Each of these conditions comprised 7 items regarding different modality of a future experience (safety, pleasure, privilege, compatibility with own lifestyle, anger, importance, usefulness to others).
The survey ended with socio-demographical questions and a self-rated expertise scale (adapted from Johanna and van der Heijden, 2000).
Collected data were coded by a first user researcher and then cross-checked by a second one. Two dependent variables were extracted from the transcripts for these preliminary results: *fluency* (number of unique needs generated per participant) and *elaboration* (average word count per need). These variables (together with *flexibility* and *originality*) are commonly used to assess creativity (Lubart et al., 2015).

5. Preliminary results

ANOVA tests were run to measure the effect of the independent variables (namely future projection tasks, collection tool, system definition level, topic; see 3.2 for details).
Regarding fluency, there was no effect of topic ($F(1,189) = 3.851$; $p = .051$, $\eta^2_p = .017$), future projection tasks ($F(1,189) = 2.291$; $p > .05$, $\eta^2_p = .010$) , collection tools ($F(1,189) = 0.720$; $p > .05$, $\eta^2_p = .003$) or system definition level ($F(1,189) = 2.230$; $p > .05$, $\eta^2_p = .010$).
Regarding elaboration, there was a significant effect of future projection tasks ($F(1,189) = 4.550$; $p = .034$, $\eta^2_p = .020$) with a higher elaboration with future projection tasks than without (M=8.09, SD= 4.21 and M=7.03, SD=3.74) (see Figure 1).

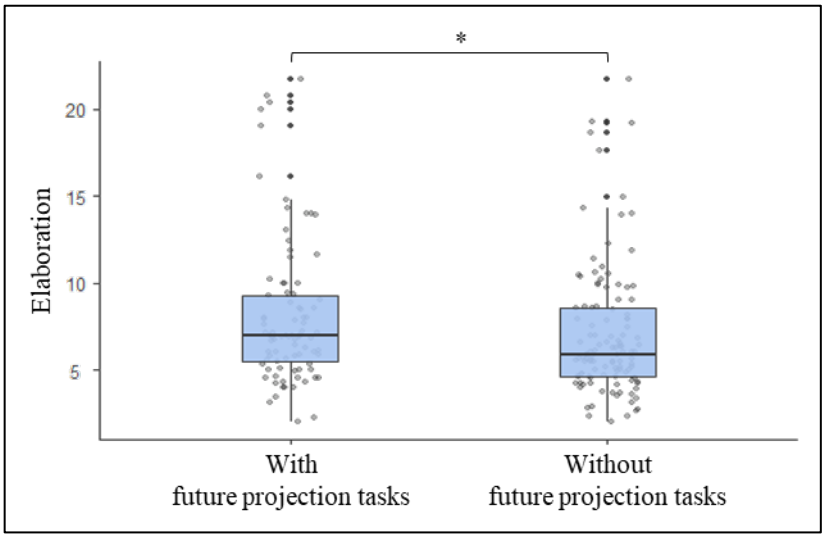

Figure 1: Box plot of elaboration depending on future projection tasks

A significant effect was also observed for collection tools ($F(1,189) = 0.720$; $p < .001$, $\eta^2_p = .058$) with a higher elaboration for the open-ended questions over the sentence completion test (M=8.68, SD= 4.89 and M=6.60, SD=2.84). A significant effect was observed for system definition ($F(1,189) = 4.290$; $p = .040$, $\eta^2_p = .019$) with a higher elaboration for ill-defined systems over yet-unknown systems (M=8.04, SD= 4.19 and M=6.94, SD=3.69). There was no

effect of the topic ($F(1,189) = 1.282$; $p = .259$, $\eta^2_p = .006$). For both fluency (r(203) = -.025, p = .722) and elaboration (r(203) = .52, p = .462) there was no correlation with self-rated expertise.

6. Conclusion

The study illustrates the effect of two future projection tasks on needs' elaboration (in average one more word has been collected with the projection task). No significant effects on fluency has been found. More detailed studies will be necessary to calibrate and further test the effect of the tasks. The treatment of additional dependent variables (originality, flexibility) will also help to better measure the effects.

Other significant effects on elaboration were identified such as better results when the participants answered the open-ended questions (vs. the sentence completion tests). No effect of expertise on elaboration nor fluency was detected. The effects could be explained by the positive result of the projection tasks on the quality of participants' representations thus stimulating the evocation of needs (Loup-Escande et al., 2014) and reducing the *psychological distance* when thinking about distant (time/space) objects (Trope and Liberman, 2010).

This study is a starting point in elaborating methods to support the collection of future needs for prospective ergonomics and other foresight-oriented fields. Current work is underway in prospective ergonomics to integrate such methods in user research interviews.

7. Limits

The first limit comes from the design of the survey: it was possible for participants to skip the audio recording of the modified GIP (or at least not fully follow the projection task guidelines) and still answer the verification questions.

Despite being significant, the difference between the presence/absence of future projection tasks on the average elaboration is not very strong and calls for i) designing more refined future projection tasks, ii) comparing several tasks to determine which is the best, iii) checking if the projection tasks are successful.

To assess the quality of needs collected we used two criteria derived from the psychology of creativity (fluency and elaboration) with two others (originality and flexibility) still to be assessed. It is probable that we could use better suited criteria such as those proposed by Barré et al. (2018) who suggests using only usefulness, fluency and originality as relevant metrics for evaluating needs.

8. Directions for future research

As we discussed earlier both episodic memory and semantic memory have a role in MTT, in future studies it would be important to find future projection tasks that can stimulate both in order to collect needs specifics of each. The work from Pettersson and Karlsson (2014) – while not referring to semantic/episodic memory – is an interesting inspiration regarding the specificity of stimuli. Two projection tasks where used i) collage and images of future cars/cities (general concepts), ii) enactment of future experiences (personal concepts) within a very rough prototype of a car. For the first one the researchers collected mainly general insights (on life, architecture, technology) while for the second one they collected more personal insights (on interactions).

Since MTT uses past experiences from the memory systems, future studies could take it into account by opening up to tools used to elicit a better recollection of past memories/problems that could give rise to a more efficient MTT. Such tools could provide or elicit imagery, a sense of presence, a narrative structure, a spatial setting/context, feelings of familiarity etc. (Hassabis et al., 2007; Rubin et al., 2003; Wagner et al., 2005).

In addition to mental time travel, other cognitive processes could be candidates for priming such as *counterfactual thinking* and *perspective taking*. These processes, together with MTT, were primed successfully by a group of researchers (Fredericks et al., 2019) in order to improve the quality of new venture ideas in entrepreneurs. Additional methods could also be of use such as methods from the field of *problem solving*.

To conclude with, the ubiquity of digital devices might have effects on the way humans use their brain (Barr et al., 2015; Ward et al., 2017) following the (re)location of much of our memories to electronic devices. This is not new and the transfer of memories to external media has continuously increased since the successive discoveries of writing, printing, audio recording etc. Could this remodel or compromise our memory systems to the point where our ability to imagine the future is altered? How can we take this into account when eliciting future needs? Could studying the data traces left in phones, computers, social media… be another opportunity to find new needs?

Acknowledgement

This work was supported partly by the French PIA project « Lorraine Université d'Excellence », reference ANR-15-IDEX-04-LUE. This work has also been partly supported by a CIFRE grant by ANRT on behalf of the French Ministry of Higher Education, Research and Innovation.

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