**MBB online testing during (and after) COVID public containment: technical note**

1. **Context, motivation**

The current COVID epidemic has required extraordinary public health measures in most countries around the world. In France, containment has started on the 11th of March 2020, and ended on the 18th of May 2020. Many people were staying at home, in a situation of partial social isolation. In turn, this may have induced psychological distress, which may have resulted in elevated anxiety and/or depressed mood. In turn, people may still experience anxiety and/or mood distrubances.

From a scientific perspective, this may be a unique opportunity to study the relationship between ongoing fluctuations of anxiety/mood states and cognitive processes. In particular, we aim at exploring the co-occurring fluctuations in specific aspects of social cognition, self-control and self-efficacy learning.

1. **Overview**

We will recruit 100 participants from the RISC platform (after having obtained their informed consent), and follow them through the containment period and beyond. Each participant will log in an online web testing platform (see below) according to pre-defined schedule (see below). Each testing session comprises three different cognitive tests and psychiatric questionnaires assessing mood/anxiety and apathy, as well as a questionnaire evaluating participants’ subjective assessment of their containment situation.

Participants will be financially rewarded at a base rate of 8€ per session, plus a performance-based bonus that depends on the test (see below).

Note: we will need to contact each participant by email according to the testing schedule, in order to remind them of the timing of testing session.

1. **Cognitive tests**
   1. **Self-control**

Self-control refers to the ability to regulate one’s actions, thoughts and emotions. Stimuli that evoke emotions attract our attention more rapidly and more efficiently that “neutral” stimuli. Although this attentional bias towards emotional objects may provide some evolutionary advantage on average, it may also impair adapted cognition. For example, it may be problematic to be distracted by an emotional stimulus rather than prioritize the attentional processing of an information that is relevant to one’s current goal. In other words, emotional content is only advantageous or beneficial if it prioritizes the processing of a stimulus that is relevant for the one’s current goal. However, the voluntary control of this emotional bias may be difficult, and hence demand an increased allocation of attentional resources. Our working hypothesis here is that this control results from a motivational arbitrage between the cost of cognitive effort and the ensuing benefit.

We use the so-called Rapid Serial Visual Presentation (RSVP) protocol, in which a series of fearful and neutral faces are briefly presented to the participant in a continuous flow. Participants have to detect the gender of the “target” face, which is shown right after a “distractor” face that induces an attentional blink. Let’s consider the performance gap between a situation in which the target is a fearful face and the distractor is a neutral face (beneficial condition or BC), and the inverse situation (detrimental condition or DC). This gap quantifies one’s inability to inhibit the emotional bias. We define “control efficacy” in terms of the reduction of this gap when reward at stake increases.

* + 1. **Design**

The full experimental session is a 2x3 factorial design:

* Factor 1 = reward: 2 levels (high: 2€ and low: 0.05€ per correct answer)
* Factor 2 = emotion “usefulness”: 3 levels (beneficial, detrimental and control)

There are XXX trials per cell in the factorial design, which means XXX trials in total.

* + 1. **Testing schedule**

We expect this test to have good test-retest psychometric properties (in particular: session-to-session spill-over effects should be negligible).

Therefore, we set the testing schedule as follows:

* Months #1 and #2: every week, with a 4-days testing window (starting each Friday).
* Months #3 and #4: every two weeks, with a 4-days testing window (starting each Friday).
* Months #5 and #6: every month, with a 4-days testing window (starting each Friday).
  + 1. **Notes**

The timing of stimulus presentation requires a relatively high temporal precision, since the attentional blink effect is optimal when targets and distractors are presented during 70 msec with null ISI.

The full experimental session uses 242 face images (Chicago Face Database), which need to be loaded prior to each testing session.

We need to record participants’ choice and reaction time at each trial.

Participants’ performance-dependant bonus depends upon the accuracy of their responses during each session (1 trial is randomly selected in each reward condition, yielding a maximal bonus of 2.05€).

* 1. **Social cognition**

Social cognition refers to the cognitive processes involved in handling social interactions with others. It includes, but is not limited to, (i) the perception, recognition and/or understanding of others’ beliefs, preferences and emotions, and (ii) the ability to influence and/or be influenced by others’ beliefs, preferences and emotions. Let us consider attitudinal traits, such as prudence. From the perspective of decision theory, prudence refers to ones’ subjective attitude towards risk. More precisely, someone prudent is strongly devaluating the prospect of a reward if it associated with a high risk. Here, we focus on (i) peoples’ ability to recognize others’ prudence from their behaviour, and (ii) the attitude alignment that ensues.

We adapt a previously published dual computational/empirical test (Devaine and Daunizeau, 2017), that alternates between *decision* and *prediction* phases. In *decision* phases, participants are asked to choose between two alternative options, which differ in terms of reward and risk (e.g., 10€ versus 10% chance of winning 100€). These alternatives are matched in terms of expected utility, and involve two different framings: namely: a loss frame and a gain frame. We measure participants’ prudence and framing bias from their choices. In *prediction* phases, participants have to progressively learn the risk attitude of “dummy participants”, who are presented with similar alternative options. In fact, dummy participants are artificial decision makers that reproduce realistic people behaviour (see below). At each trial, we show participants what options are offered to the dummy, ask them to bet on what the dummy will choose, and then show them what the dummy has chosen.

We measure participants’ ability to understand others’ risk attitude in terms of their performance in *prediction* phases. We measure attitude alignment in terms of participants’ relative change of risk attitude (between two decision phases) towards the preceding dummy (in the corresponding interleaved *prediction* phase).

* + 1. **Design**

The full experimental session consists of two conditions:

* The social condition comprises 5 *decision* phases, interleaved with 4 *prediction* phases. Each *prediction* phase involves a specific dummy (which is impersonated using a specific name), whose risk attitude varies according to both framing bias and risk devaluation. There are 32 trials per *decision/prediction* phase (+2 catch trials per *decision* phase), which means 298 trials in total.
* The non-social control condition comprises only 1 *prediction* phase, which is match with the social condition in terms of learning requirements. At each trial, participants are presented with two ecological systems that differ w.r.t. two features (fertility and sensitivity to predators). They then bet on which of these two systems will yield the most offspring. They then are told which ecosystem actually yielded the most offspring. The hidden efficacy of ecosystems is probabilistic, and matched with one of the dummy hidden value function from the social condition. We measure participants’ ability to understand non-social complex systems in terms of their performance (this serves as a control for the corresponding *prediction* phase of the social condition). There 32 trials in total for the non-social condition (i.e. the experimental session consists of 330 trials).
  + 1. **Testing schedule**

We expect this test to have good test-retest psychometric properties (in particular: session-to-session spill-over effects should be negligible).

Therefore, we set the testing schedule as follows:

* Months #1 and #2: every week, with a 4-days testing window (starting each Friday).
* Months #3 and #4: every two weeks, with a 4-days testing window (starting each Friday).
* Months #5 and #6: every month, with a 4-days testing window (starting each Friday).
  + 1. **Notes**

The timing of stimulus presentation does not require high temporal precision, since *decision* and *prediction* phases are self-paced.

We need to record participants’ choice and reaction time at each trial.

Participants’ performance-dependant bonus depends upon the accuracy of their responses in *prediction* phases during each session (1 trial is randomly selected, yielding a maximal bonus of 2€).

* 1. **Self-efficacy learning**

Here, self-efficacy refers to one’s belief regarding how much effort one has to invest to reach a given performance level (in any cognitive or physical task). Self-efficacy is a major determinant of motivation, in the sense that it determines one’s perceived best trade-off between reward and effort costs. Importantly, when acquiring a new skill or engaging in a new task, self-efficacy has to learned. Such self-efficacy learning may be prone to cognitive biases when acquiring a new skill. In particular, people may overweigh successes when compared to failures (optimism bias), neglect prediction errors (confirmatory biases), or report elevated levels of confidence (overconfidence bias). Here, we study the determinants of self-efficacy learning, in terms of either external feedbacks (regarding one’s objective performance in a task) or internal feedbacks (regarding one’s subjective confidence in the task). We also quantify the potential optimism, confirmatory and overconfidence biases that distort self-efficacy learning.

We use a simple short-term memory task that is adapted from the “Memory” game, in which people must learn the location of pairs of twin items within a 4x4 grid of cards. The pairs are presented sequentially at a rate of one pair per second. On each trial, participants are given a target number of pairs to remember to win a bonus for that trial. Participants can choose to see one presentation of all the pairs (a so-called “flip”) as many times as they choose during a trial (*encoding* phase). Then, they are shown one member of each twin pair at a time and are asked to designate the location of the corresponding twin item on the grid (*recall* phase), up to the target number of pairs for that trial. Before, they are provided with their objective performance, they then are sked to provide their confidence level in reaching the target performance level. Additionally, prior to the encoding phase, participants are asked to report the number of ‘flips’ of the 4x4 grid they believe they would need to achieve the target score for that trial. Finally, on certain trials, participants will not be required to complete the recall phase and instead simply report how confident they are that they would have achieved the target score.

Repeating this procedure over trials allows us to monitor the progressive update of self-efficacy and its potential associated learning biases.

* + 1. **Design**

The full experimental session simply consists of a repetition of 30 trials of the game.

* + 1. **Testing schedule**

We do not know whether this test possesses good test-retest psychometric properties. In particular, session-to-session spill-over effects may be present, given that participants may have saturated self-efficacy learning over previous sessions.

Therefore, we set the testing schedule as follows:

* Months #1 and #2: every week, with a 4-days testing window (starting each Friday).
* Months #3 and #4: every two weeks, with a 4-days testing window (starting each Friday).
* Months #5 and #6: every month, with a 4-days testing window (starting each Friday).
  + 1. **Notes**

The timing of stimulus presentation does not require high temporal precision, since *encoding* and *recall* phases in both *decision* and *prediction* phases are self-paced.

We need to record participants’ responses and reaction times at all phases of each trial.

Participants’ performance-dependant bonus depends upon the accuracy of their responses during each session (1 trial is randomly selected, yielding a maximal bonus of 2€).

* 1. **Reward-Effort trade-offs**

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* 1. **Questionnaires**

After completion of each behavioural session, participants will be asked to answer two quick self-report questionnaires, namely: the HADS (Hospital Anxiety and Depression Scale) and the Starkstein Apathy Scale. In addition, they will be asked to fill-in a self-made questionnaire that evaluates their personal containment situation (“containment questionnaire”).

1. **IT requirements**

Participants will register on a RedCap ICM/PRISME server, which will ensure a secure (and RGPD-compliant) storage of a register of participants’ identity, contact and banking information. Upon registration, a login ID and a password will be available to each participant for the behavioural sessions. Only PRISME administrators will have access to this register.

All tasks will be coded in JavaScript, and hosted on an ICM/PRISME Apache server.

A MySQL database (and associated RGPD-compliant backup system) will be set up and managed by the ICM/PRISME platform, with the help f the ICM/DSI.

A dedicated emailing system will be used to inform each participant about the upcoming behavioural testing session, 2 days prior to each testing window. Note that tests do not have the same testing schedule (in particular: the self-efficacy learning test has a relatively sparser testing schedule).

Below is a schematic summary of the IT architecture of the project:

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| --- | --- |
|  | * External users will access the ICM Apache server using a secure protocol (SSL key) * This server will host the javascript code that is requires for the online testing sessions, and record participants’ test results and questionnaire responses. * This ICM Apache server will send encrypted data to a secure Amazon MySQL database, which will be backed-up every week. |