

The power of distraction: An experimental test of Quantum Persuasion *

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Abstract

Quantum-like decision theory is by now a well-developed field. We here test the predictions of an application of this approach to persuasion as developed in Danilov et al. (2018b). One remarkable result entails that in contrast to Bayesian predictions, distraction rather than relevant information has a powerful potential to influence decision-making. We conducted an experiment in the context of donations to NGOs active in the protection of endangered species.

We first tested the quantum incompatibility of two perspectives 'trust' and 'urgency' in a separate experiment. We next recruited around 900 respondents and divided them into three groups: a control group, a first treatment group and the main treatment group. Our main result is that only 'distracting' information significantly affected decision-making; it induced a switch in respondents' choice as to which project to support compared with the control group. The first treatment group who was provided with compatible (general) information exhibited no difference compared with the control group. Population variables play no role suggesting that quantum-like indeterminacy may indeed be a basic regularity of the mind. We thus find support for the thesis that the manipulability of people's decision-making is linked to the quantum indeterminacy of their subjective representations (mental pictures) of the choice alternatives.

1 Introduction

The theory of persuasion was initiated by Kamenica and Gentskow [10] and further developed in a variety of directions. The subject matter of the theory of persuasion is the use of an information structure (or measurement) that generates new information in order to modify a person's state of beliefs with the intent of making her act in a specific way. The question of interest is how much can a person, call him Sender, influence another one, call her Receiver, by selecting a suitable measurement and revealing its

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outcome. An example is in lobbying. A pharmaceutical company commissions to a scientific laboratory a specific study of a drug impact, the result of which is delivered to the politician. The question of interest from a persuasion point of view is what kind of study best serves the company's interest.

Receiver's decision to act depends on her beliefs about the world. In [10] and related works the beliefs are given as a probability distribution over a set of states of the world. A central assumption is that uncertainty is formulated in the standard classical framework. As a consequence the updating of Receiver's beliefs follows Bayes' rule.

However as amply documented the functioning of the mind is more complex and often people do not follow Bayes rule. Cognitive sciences propose alternatives to Bayesianism. One avenue of research within cognitive sciences appeals to the formalism of quantum mechanics. A main reason is that QM has properties that reminds of the paradoxical phenomena exhibited in human cognition. As argued in e.g., ([?]) there also exist deeper reasons for turning to quantum mechanics when studying human behavior. Moreover cognition has been successful in explaining a wide variety of behavioral phenomena such as disjunction effect, cognitive dissonance or preference reversal (see [9], [2]). Finally, there exists by now a fully developed decision theory relying on the principle of quantum cognition (see [4, 5]). Clearly, the mind is likely to be even more complex than a quantum system but our view is that the quantum cognitive approach already delivers interesting new insights in particular with respect to persuasion.

In quantum cognition, the system of interest is the decision-maker's mental representation of the world. It is represented by a *cognitive state*. This representation of the world is modelled as a quantum-like system so the decision relevant uncertainty is of non-classical (quantum) nature. As argued in ([8]) this modeling approach allows capturing widespread cognitive difficulties that people exhibit when constructing a mental representation of a 'complex' alternative (cf [3]). The key quantum property that we use is that some characteristics (cf. properties) of a complex mental object may be "Bohr complementary" that is incompatible in the decision-maker's mind: she cannot combine in a stable way pieces of information from the two perspectives. A central implication is that measurements (new information) modifies the cognitive state in a non-Bayesian well-defined manner.

As in the classical context our rational Receiver uses new information to update her beliefs so that choices based on updated preferences are consistent with ex-ante preferences defined for the condition (event) that triggered updating. In [5], we learned that a dynamically consistent rational quantum-like decision-maker updates her beliefs according to the von Neumann-Lüders postulate. In two recent papers, important theoretical results were established. First, it is shown in ([6]) that in the absence of any constraints on measurements, full persuasion applies: Sender can always persuade Receiver to believe anything that favors him. Next, in ([7]) the same authors investigate a short sequence of measurements but in the frame of a simpler task that we call "targeting". The object of "targeting" is the transition of a belief state into another specified target state. The main results of relevance to our issue is that distraction "providing" irrelevant or "incompatible" information has significant persuasion power. In a Bayesian context such information should have minimal or no effect at all.

The present paper aims at testing experimentally that later prediction. More precisely, we want to test whether an information (outcome of a measurement) belonging to a perspective that is incompatible with the information relevant for the decision at stake can affect decision-making. That is we test the concluding statement in Akerlof and Shiller’s book ([1]) ”just change the focus of people’s mind and you change the decisions they make”.

The situation that we consider is the following. People are invited to choose between two projects aimed at saving endangered species (Elephants and Tigers). The selected project will receive a donation of 50 euros (one randomly selected respondent will determine the choice). We consider two perspectives of relevance for the choice: the urgency of the cause and the trustworthiness (or honesty) of the organization that manages the donations. As a first step, in a separate experiment we establish that the two perspectives are incompatible by exhibiting a significant order effect. In the main experiment around 900 respondents were divided into three groups: a control and two treatment groups. They all go through a presentation of the projects and some questions about their preferences. The difference between the groups is that the first treatment group receives general additional information compatible with their (elicited) preferences while the second one receives general additional information incompatible with their preferences.

The results are in accordance with the predictions of the theoretical model: incompatible information has a significant impact so the respondents switched their choice as compared with the control. Compatible information has no impact compared to the control group. None of the population variable has any impact. This suggest that the quantum model may indeed capture basic regularities of the mind relevant to decision-making.

2 The quantum persuasion approach

Let us first briefly describe the classical approach developed by Kamenica and Genstkow ([10]), Bayesian persuasion. We have a person call him Sender who tries to influence a decision-maker call her Receiver by means of an information structure or a measurement that generates information. Information affects Receiver’s beliefs which in turn affect her evaluation of uncertain choice alternatives and therefore the choice she makes. In the classical context Receiver updates her beliefs using Bayes rule and therefore the power of Sender is constrained by Bayesian plausibility: the fact the expected posteriors equal the priors.

The quantum persuasion approach has been developed in the same vein as the Bayesian persuasion. A central motivation is that persuasion seems much more effective than what comes out of the Bayesian approach. So instead of assuming that agents are classical Bayesian, it has been proposed that they are quantum-like. This means that the representation of reality upon which they make decision does not evolved according to Bayes rule but follows instead von Neumann-Lüder’s rule (vNL). vNL updating has been shown as an expression of dynamic consistency in such a context (see [5]).

The present paper aims at experimentally testing some prediction of the theory of quantum persuasion.

More precisely as shown in ([7]), Sender can use ‘distracting’ measurements as tools to influence Receiver. A distracting measurement corresponds to a measurement that generates information that is incompatible (or Bohr complementary) with the information used by Receiver to evaluate the choice alternatives. The objective is to switch the focus of Receiver’s mind (distract her) which changes her cognitive state or her beliefs although no information relevant to her concern is provided. The following example from ([6]) illustrates the point:

Example

A consumer is considering the purchase of a second hand smartphone at price 30 euros of uncertain value to her, it depends on its technical quality which may be standard or excellent. She holds subjective beliefs about the probability that the smartphone is excellent. Based on those beliefs, she assigns an expected utility value to the smartphone which determines her decision to buy or not the item. Receiver’s expected utility for the smartphone in the belief state B is represented by the trace of the product of operators A and B ¹:

$$Eu(A; B) = \mathbf{Tr}(AB) = (1/5) * 100 + (4/5) * 0 = 20 < 30 = u.$$

Given belief B Receiver does not want to buy the smartphone so the seller earns 0.

Can Sender persuade Receiver to buy by selecting an appropriate measurement? Consider another property (perspective) of the smartphone that we refer to as Glamour (i.e. whether celebrities have this brand or not). The two properties (perspectives) are assumed incompatible in the mind of Receiver. Receiver can think in terms of either one of the two perspectives but she cannot synthesize (combine in a stable way) pieces of information from the two perspectives. This is illustrated in figure 1.

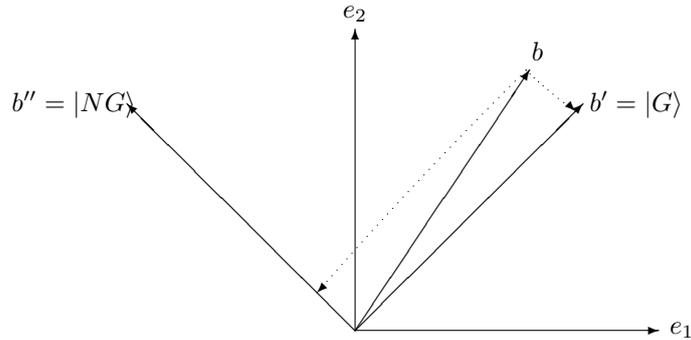


Figure 1.

Assume that Sender brings the discussion to the Glamour perspective and performs the measurement so Receiver learns whether her preferred celebrity has this smartphone. With some probability p (say 0.9) the new cognitive state is $B' = Q_1$ and with the complementary probability $1 - p = .1$ it is $B'' = Q_2$.

¹For a complete formulation of choice theory in the quantum context see [5].

We note that $Eu(A; B') = \mathbf{Tr}(AB') = 50 > 30$ and $Eu(A; B'') = \mathbf{Tr}(AB'') = 50 > 30$. In both cases Receiver is persuaded to buy and Sender gets utility 10.

In the example above it is easy to show that the new belief state violates Bayesian plausibility - the expected posteriors for the event 'the smartphone is excellent' is $p.5 + (1-p).5 = .5$ which is larger than the priors which equals .2. Moreover the measurement Glamour is not relevant to the beliefs about the quality of the used smartphone. It is a distraction. Yet it affects the beliefs and the associated decision. In a Bayesian context irrelevant/uninformative data do not modify beliefs and therefore cannot be used as means of persuasion.

3 Experimental design

Our main experiment uses the property of Bohr complementarity of mental perspectives, i.e., their possible incompatibility in the mind of Receiver. More precisely it relies on the assumption that two relevant perspectives on a project aimed at saving an endangered species are incompatible. The two perspectives that we consider are "the urgency of the task" and the "trustworthiness (honesty)² of the organization that receives and manages the funds". As a first step we want to provide support for this hypothesis. Two properties are incompatible if measuring them in different orders yields different results. In quantum cognition asking a question about preferences is a measurement of those preferences. Therefore, we started with an experiment to check whether order matters for the response profile obtained. Note that even in Physics there is no theoretical argument for establishing whether two properties are compatible or not. This must be done empirically.

3.1 Testing for perspective incompatibility

295 participants completed a short survey on the website Typeform. They were recruited through Amazon's Mechanical Turk; for which data quality has been confirmed by different studies (Bartneck et al. 2015). They were paid \$0.1 and spent on average 0:17 minute to complete the survey.

Participants were first presented a short description of the situation of refugees in Myanmar with mention of the main humanitarian NGO present in the field.³

"About a million refugees (a majority of women and children) escaped persecution in Myanmar. Most of them fled to Bangladesh. The Bengali Red Crescent is the primary humanitarian organization that is providing help to the Rohingyas. They are in immediate need of drinkable water, food, shelter and first medical aid."

²The two terms are used interchangeably consistently with the definition given to honesty - see below.

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Bangladesh. The Bengali Red Crescent is the primary humanitarian organization that is providing help to the Rohingyas. They are in immediate need of drinkable water, food, shelter and first medical aid.

They were then asked to evaluate the urgency of the cause and the trustworthiness to the NGO on a scale from 1 (“Not urgent” or “Do not trust”) to 5 (“Extremely urgent” or “Fully trust”). The order of presentation of each question was randomized so that half of participants responded to the urgency question before trust (U-T), and the other half conversely (T-U).

The data were processed, cleaned and analyzed with Stata. Probit regression models were conducted to analyze the effect of the order of the questions on the responses. In addition, responses were clustered into two groups: low level of urgency (resp. trust) (responses₂₂₆₄₃) and high level of urgency (resp. trust) (responses₃).

The results show that the order of the question impacts significantly the responses given to both urgency (p-value=.050) and trust (p-value=.026). Regression tables can be seen in the Appendix.

Our results are consistent with the hypothesis that the two perspectives are incompatible in the mind of people. As we know there are other theories for order effect. Therefore we performed some additional regression and could eliminate both the hypothesis of a recency bias and the hypothesis of primacy bias. This strengthens our quantum interpretation. We next proceed to the main experiment using those two perspectives.

3.2 Quantum persuasion

The participants were divided into three groups. Two treatment groups and a control group as explained below. All three groups were presented a screen with an introductory message, informing them that the questionnaire was part of a research project on quantum cognition and that they will contribute in deciding which one of two NGOs projects will receive a 50€ donation. Presumably this created an incentive to respond truthfully. They were then asked to click on a button that would randomly assign them to a given condition. In all conditions, participants were shown a short text about elephants and tigers in association with an NGO working for their protection respectively the Elephant Crisis Fund (ECF) and Tiger Forever (TF). The order of presentation of the text was reversed for half of the subjects. This aimed at avoiding irrelevant to our point order effects. The texts contained a brief description of the dramatic situations of elephants (resp. tigers) and of ongoing actions by the NGOs.

”Elephant crisis fund : A virulent wave of poaching is on-going with an elephant killed for its tusks every 15 minutes. The current population is estimated to around 700 000 elephants in the wild. Driving the killing is international ivory trade that thrives on poverty, corruption, and greed. But there is hope. The Elephant Crisis Fund closely linked to World Wildlife Fund (WWF) exists to encourage collaboration, and deliver rapid impact on the ground to stop the killing, the trafficking, and the demand for ivory.”

Tiger Forever : Tigers are illegally killed for their pelts and body parts used in traditional Asian medicines. They are also seen as threats to human communities. They suffer from large scale habitat loss due to human population growth and expansion. Tiger Forever was founded 2006 with the goal of reversing global tiger decline. It is active in 17 sites with Non-Governmental Organizations (NGOs) and government partners. The sites host about 2260 tigers or 70% of the total world’s tiger population”

It is worth mentioning that the descriptions were formulated so as to slightly suggest that the elephants' NGO (EFC) could be perceived as being more trustworthy (because of its link with WWF, a well-known NGO). The text about tigers in contrast suggests a higher level of urgency (a mention was made of the absolute number of remaining tigers, significantly lower than the number of remaining elephants). Thereafter all respondents were asked

"When considering donating money in support of a specific project to protect endangered species, different aspects may be relevant to your choice. Let us know what counts most to you" formulated as follows:

"The urgency of the cause: among the many important issues in today's world, does the cause you consider belong to those that deserve urgent action? or

"The honesty of the organization to which you donate: do you trust the organization managing the project to be reliable; i.e. do you trust the money will be used as advertised rather than diverted."

The objective was to elicit their preferences in the sense of which perspective was most important. The rest of the experiment depended on which one of three groups the participants belonged to.

In the first control condition (baseline) they were next asked whether or not they wanted to read the first descriptions again or if they wanted to make their final decision i.e., to choose between supporting Elephant Crisis or Tiger Forever both represented by an image of an adult tiger respectively adult elephant (also delivered in random order on a line).

In the first treatment condition, they were redirected to a screen with general information compatible with the aspect they indicated as determinant to their choice when making a donation. Importantly the information did not favor or disfavor directly or indirectly any of the two projects. Then they were offered the opportunity to read again the descriptions before deciding or directly make their image choice between ECF and TF. Those who responded honestly saw:

"Did you know that most Elephant and Tiger projects are run by Non-Governmental Organizations (NGOs) ? But NGOs are not always honest ! NGOs operating in countries with endemic corruption face particular risks. NGOs are created by enthusiastic benevolent citizens who often lack proper competence to manage both internal and external risks. Numerous scandals have shown how even long standing NGOs had been captured by less scrupulous people to serve their own interest.

So a reasonable concern is whether Tiger Forever or Elephant Crisis Fund deserves our trust."

Those who responded urgency saw:

"Did you know that global wildlife populations have declined 58% since 1970, primarily due to habitat destruction, over-hunting and pollution. It is urgent to reverse the decline ! "For the first time since the demise of the dinosaurs 65 million years ago, we face a global mass extinction of wildlife. We ignore the decline of other species at our peril – for they are the barometer that reveals our impact on the world that sustains us." — Mike Barrett, director of science and policy at WWF's UK branch. A reasonable concern is how urgent protecting tigers or elephants actually is."

In the main treatment condition, participants were redirected to a screen with general information on

the aspect they did not select as determinant. So those who selected honesty(urgency) saw the screen on global wildlife decline (NGO's scandals). As for the first treatment group, the information did not favor or disfavored directly or indirectly any of the two projects. Then they were offered the opportunity to read again the description before deciding or directly make their image choice.

Finally, information about their age, gender, education and habits of donation to NGOs was collected before the thank-you message and the end of the experiment.

More than 900 participants completed the survey on the website Typeform and were recruited through Amazon's Mechanical Türk. They were paid either \$1 to 0.75\$ (for the shorter baseline survey) depending on their conditions. They spent on average 1:33 minute for the experiment. 49% of them were female, 61% male, the mean age was 35 years, and their mean education level was undergraduate level.

3.3 Predictions

Before getting into the results and their analysis. Let us remind of what the main predictions are.

First, what concerns treatment group 1 who received compatible information, the predictions of both the Bayesian and the quantum model are the same. Namely that general information should have a no effect or a slightly reinforcing effect compared with the control group' choice of whom to donate. This treatment group is useful to reject the argument that any additional information upsets people's beliefs and thus affect their choice.

What the main treatment group concerns the prediction are clearly distinct. The Bayesian model predicts that general information on an issue that is not determinant to choice should have no effect or a very small counter-balancing effect. The counter-balancing effect would be due to the fact that even if say "trustworthiness" is determinant, it needs not mean that urgency is irrelevant. In contrast, the quantum persuasion model predicts that the distraction provided to the treatment group could significantly modify the allocation of responses compared to the control group. It should be noted that since we lack information about the exact correlation coefficients between the two perspectives, we do not have precise quantitative predictions. We know that the less correlated the two perspectives (in the example of section 2 they were fully uncorrelated) the larger the expected impact in terms of switching the choice.

4 Results

The number of observations that were retained was 900. We conducted a number of probit regressions performed with Stata.

The first set of results establishes that incompatible information has a statistically significant* impact on the final choice which tends to significance **. This result stands when the regression includes all variables (p=0.11), when it only accounts for compatible and incompatible information (p=0,09) and when in addition it accounts for population variable (age, gender, education, contribution to NGOs)

($p=0,13$). There is no impact of compatible information in any of those regressions. Not surprisingly there is an impact of the choice of determinant i.e., honesty versus urgency which captures preferences ($p=0,025$). None of the population variables had any impact on the final decision.

Given the significance of preferences, we performed a second regression to investigate the interaction between preferences and the treatments in comparison with the control group. We find that preferences are significant ** ($p=0,04$) when the conditions are controlled for. Compatible information has no impact when preferences are controlled for while incompatible information has significant impact ($p=0,11$) when preferences are controlled for. These results implies that incompatible information induced ‘a true switch’ independently of preferences. .

4.0.1 Interpretation

The results show with no ambiguity that incompatible information that is ”distraction” had a significant impact on the final choice by inducing some extent of switch as compared to both the control group and the compatible information group.

These results are fully consistent with the predictions of the quantum persuasion model and contradict the predictions of the Bayesian model with respect to the impact of incompatible information. Moreover the fact that general compatible information had no impact also supports the view that it is not merely ”information” that affects the choice because the person is slightly ”upset”. Instead it is only when information induces a change in perspective that something happens.

The importance of elicited preferences i.e., the answer to ”what is determinant to your choice” to the final choice underlines that the initial texts were well-understood. The description of the Elephant project was designed to suggest more trust to the NGO managing the project and the Tiger project to suggest higher level of urgency. The proportion of the respondents that declared that honesty (urgency) was determinant is about the same as the proportion of the respondents who chose to support the Elephant Crisis Fund (Tiger For Ever).

The time for responding to the whole questionnaire was between 1 and 3 minutes which is rather quick. This we view as a good thing because the quantum working of the mind is not rational reasoning: no new information of relevance for the choice was provided yet it did affect the choice. The respondent did not take time to reflect, they reacted spontaneously to the distraction. We did not elicit their preferences for the projects but only for the determinants. We found that those determinants are highly correlated with the choices in the control and compatible information groups. Yet, the results suggest that respondents were not conscious of that. Therefore, they were not confronted with a (conscious) cognitive dissonance when the distraction changed their focus and eventually affected their decision.

We note that the respondents were given a chance to reassess their understanding of the project by re-reading them before making their choice. Only 15% used that opportunity. This can be viewed as an attempt to think more to try to be more consistent. Interestingly, the decision to reread is significantly correlated with age**, education*, gender*, and NGO**.

Yet, another very interesting feature is that the results are fully independent of population variables which supports the hypothesis that the quantum-like structure is a general regularity of the human mind. Given the complexity of the human mind, we did not expect such straightforward results.

5 Discussion and concluding remarks

In the experiment we performed, the incompatible information i.e., the change of focus affected revealed preferences for uncertain alternatives. Revealed preferences express both preferences and beliefs. The present paper is a test of the theory of quantum persuasion which focuses on beliefs. Therefore we interpret the results as distraction affecting beliefs. When it comes to information processing related to the outside classical world, quantum indeterminacy of beliefs is not consistent with rationality. When Receiver processes information about a classical object as if it was a quantum system, she is mistaken. But as amply evidenced by Kahneman's best selling book "Thinking Fast and Slow", information processing is not always disciplined by rational thinking when the brain processes information quickly. As proposed in ([4]) the learning process adapted to the quantum-like world may be appropriate when you are interested in actions/decisions produced by other people as they would also have a quantum-like representation of the world. So, fast quantum-like information processing is inappropriate when dealing with simple decision involving classical objects. But it may be suitable in many situations involving human beings. We believe we should not dismiss quantum-like information processing as overly irrational. The question of rationality in a context where mental objects exhibit quantum-like features deserves further investigation.

Beliefs are mental objects but preferences are mental objects too. A number of papers (e.g. Lambert-Mogiliansky, Zwirn and Zamir 2009) argue that various behavioral anomalies can be explained when assuming that preferences are indeterminate. Our experimental results are consistent with the hypothesis that the change in focus affected intrinsically indeterminate preferences between Tiger Forever and the Elephant Crisis Fund (or urgency and trustworthiness). With such an interpretation, revealed preferences do not contradict rationality. The contextuality of preferences and their related instability runs counter the hypothesis of a stable individual identity however. But the stability or the independent existence of an identity is merely an hypothesis contradicted by a number of facts (see section 2 in [12]). We close this short discussion by proposing that the quantum-like nature of mental objects needs not reflect a cognitive failure but it could be the expression of the intrinsic indeterminacy (contextuality) of human reality.

Quantum cognition experiments do not have the precision of physical experiments. To a large part, this is because it is (yet) impossible to fully characterize the state of a cognitive system which is incomparably more complex than that of an atomic particle. Nevertheless, our experimental exercise shows that it may be useful to test some predictions in contrast with standard classical (Bayesian) ones. We do not believe that the quantum approach is an alternative to all other behavioral theories. Instead we believe that it provides rigorous foundations to a number of them as argued in e.g., ([12]).

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