Motivated False Memory

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Abstract

People often forget and sometimes fantasize. This paper reports a large-scale experiment on memory errors and their relation to preferential traits including time preference, attitudes toward risk and ambiguity, and psychological traits including anticipatory feelings. We observe systematic incidences of false memory in favor of positive events and selective amnesia in forgetting negative events. Intriguingly, both positive delusion and positive confabulation significantly relate to present bias, but this is not the case for positive amnesia. In an intra-person, multiple-self model, we demonstrate that positive false memory, rather than selective amnesia, serves to enhance confidence in one's future self in equilibrium, thereby accounting for our empirical findings.

Keywords: false memory, amnesia, delusion, confabulation, present bias, anticipatory utility.

JEL Classification: C91, D03, D83, Z13

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When false is taken for true, true becomes false; If non-being turns into being, being becomes non-being.

Dream of the Red Chamber (Translated by Yang Xianyi and Gladys Yang).

1 Introduction

People often forget and sometimes fantasize. They remember what they need or what they want to remember, and hold positive self-views or rosy world-views. It is important to investigate motivated false memory from an economics perspective (Benabou and Tirole, 2016). The presence of motivated false memory has wide ranging real-life relevance, e.g., in enhancing one's self-image to boost labour market value,[1] building the academic dream to motivate research graduate students and junior professors (Cross, 1977), and creating organizational culture to enhance corporate performance (Benabou, 2013).

On the consumption side, why do people demand motivated beliefs? Individuals may need motivated beliefs to serve for certain functional values such as achieving ambitious goals. More confident individuals are well-motivated to work more (Puri and Robinson, 2007). Alternatively, motivated beliefs may simply satisfy individuals' direct affective needs. It appears that psychologically healthy people are more optimistic (Alloy and Abramson, 1979; Korn et al., 2014).[2]

On the production side, how do motivated beliefs get supplied? Individuals cannot directly choose their motivated beliefs, given the feedback of reality. To varying degrees, people process information in a motivated direction to reach conclusions they favor, including forgetfulness and false memory encompassing memory illusion and delusion (Kunda, 1990; Pashler, 1998). In psychology, it is well-documented that individuals selectively focus attention, interpret and remember information so as to enhance confidence in their ability (Dunning, 2001). Since Simon (1955), economists

[1]The importance of motivation as non-cognitive skills in labour markets has been demonstrated by Heckman and Rubinstein (2001).

[2]Relatedly, Dessi and Zhao (2018) study both theoretically and empirically the cross-country and cross-individual differences in demanding self-confidence.

have been taking this topic more seriously and attempted to propose models in which individuals simplify complex decisions by processing only a subset of the collection of the signals, e.g., imperfect recall, limited attention, and unawareness.[3] In particular, a few papers in economic theory have started to investigate the endogenous directionality of cognitive biases and contributed to study how motivated beliefs will arise and persist.[4] Along this direction, several papers investigate the potential roles of self-signaling, limited attention and selective memory in equilibrium in conjunction with present bias or anticipatory utility with self-image concern in an intra-person, multiple-self setting. Benabou and Tirole (2004, 2011), Hong, Huang and Zhao (2017) study the self-signaling value to alleviate the under-investment problem associated with present bias. Carrillo and Mariotti (2000) offer a link between selective inattention and present bias, inducing a need to sustain personal motivation by ignoring information that may weaken the individual's self confidence.[5] In Benabou and Tirole's (2002) model of selective memory, a functional role of amnesia has emerged in terms of a need to suppress recall of negative events to deliver over confidence, countering the effect of present bias leading the individual to undertake less investment activities than otherwise.[6]

[3]Limitations in memory, attention and awareness have appeared in the economics literature. Dow (1991) studies optimal search under limited memory and shows how a decision maker may focus scarce cognitive resources on part of the problem. Sims (2003) links the idea of limited attention to sources of inertia in prices and wages. Tirole (2009) and von Thadden and Zhao (2012) study the implication of limited awareness in the contracting environments.

[4]On the empirical side, there is an extensive experimental literature on asymmetric updating of information. Eil and Rao (2011) find that subjects tend to respect good signals, followed by Bayesian inference but discount or even ignore bad signals. Moebius et al. (2014) further show that subjects over-weight good signal relative to bad but process misinterpreted signals following Bayesianism, consistent with our theory. Sharot, Korn and Dolan (2012) also observe asymmetry in belief updating and identify distinct brain regions using functional brain imaging. More complementary to our paper is Zimmermann (2018) that experimentally studies the role of memory in the asymmetry in belief updating.

[5]Brown, Croson and Eckel (2011) find support of Carrillo-Mariotti's model in an experimental test.

[6]Besides personal over confidence, Svenson (1981) studies over confidence in terms of social rankings. In the test by Burks et al. (2013) of three mechanisms that can deliver over confidence, social signaling is supported while Bayesian updating (Benoit and Dubra, 2011) and concern for self

In psychology, it has been found that people exhibit false memory, and tend to be delusional in the positive direction (Fotopoulou et al., 2008). Howe (2011) reviews the bright or positive side of perceptual, cognitive and memory illusion. McKay and Dennett (2009) report many fitness relevant memory illusions, e.g., positive yet illusional self-appraisals, can lead to a sense of confidence which in turn leads to future success. Howe and Derbish (2010) and Howe et al. (2011) argue that one adaptive value of false autobiographical recollection is the tendency toward positive biasing of one's past self, which facilitates self-enhancement. When people exhibit delusion, they tend to fabricate non-existent evidence in the positive direction. In an extreme case, the neuroscientist Ramachandran (1996) documents how a patient who could not move her left arm claimed that she could engage in activities that require the use of both hands, say clapping. Additional examples include delusion of persecution in attributing one's failure to conspiracies (Bortolotti and Mameli, 2012) and the "reverse Othello syndrome" when being delusory in the fidelity of one's partner can work as a defense mechanism to maintain one's self-esteem (Burtler, 2000; McKay, Langdon and Coltheart, 2005).[7]

In economics, we explore what desirability delusion may serve, why motivational factors contribute to the formation of delusion, and how delusion interacts with other memory instruments to supply personal motivation.

The present paper studies both theoretically and experimentally memory errors and their relation to present bias along with anticipatory feelings related to self-image concern, and risk and ambiguity attitudes. In the baseline model, we extend the Benabou and Tirole (2002) model to incorporate additionally the possibility of delusion, i.e., recalling a positive signal when there was none. In Benabou and Tirole (2002), imperfect recall coupled with present bias provides a channel for the individual to form motivated beliefs and exhibits an intra-person "strategic memory management". In

image (Koszegi, 2006) are rejected. Moreover, Schwardmann and van der Weele (2016) also find that individuals who self-deceive are more successful to deceive others.

[7] Memory may also be influenced by information supplied after an event occurs (Loftus and Palmer, 1974) and false memory may be subject to manipulation by others (Loftus, 1993), including the possibility of suggestive questions distorting a witness' memory (Frenda, Nichols and Loftus, 2011).

our model, delusion and amnesia are substitutes as motivational mechanisms for the individual. We do find that the emergence of delusion results from a severe present bias. In contrast with Benabou and Tirole (2002), the chance of having selective amnesia does not depend monotonically on the magnitude of present bias because delusion invalidates the instrumental value of amnesia for sufficiently severe present bias. We also check the robustness of the theoretical results when allowing for the possibility of partial naivete and memory manipulation cost. For simplicity, our basic modeling setup excludes the possibility of confabulation, i.e., false memory transforming a negative signal into a positive one. Motivated by the observed incidence of positive confabulation and how it relates to delusion in our experiments, we build on our basic model and develop an extended model by allowing for positive confabulation in two steps: forgetting a good signal followed by deluding oneself into recalling a positive signal.

The implication of our model is tested in an experiment involving 1143 valid subjects.[8] We observe three types of memory errors: amnesia (forgetting a past event), delusion (fabricating an event that did not actually happen) and confabulation (distorting the memory of a past event into another distinct event). In the initial stage of the experiment, subjects take an incentivized Ravens IQ test after completing a number of decision-making tasks including temporal discounting, and anticipatory feelings. In a subsequent stage several months later, subjects are shown six questions, each accompanied by the correct answer, comprising four from the original test and two which are new but similar. For each question, subjects are asked to recall whether they did it correctly, did it incorrectly, did not see it, or do not remember. Subjects from our main sample (701 subjects) in Singapore receive S$1 and those from our replication sample (445 subjects)[9] in Beijing receive RMB5 for each correct recall, lose S$1 or RMB5 for each incorrect recall, and receive nothing for not remembering respectively. We find systematic incidence of memory biases in forgetting negative events and exhibiting false memory encompassing delusion and confabulation in fa-

[8]Among the 1146 subjects who complete both stages of our study, 3 Beijing subjects' numbers of correct answers of IQ test are 7, 9 and 15 respectively, which are significantly lower than the other subjects', so we drop these 3 samples as unreasonable responses.

[9]It includes the 3 invalid samples with unreasonable responses, as explained in Footnote 8.

vor of positive events. Intriguingly, positive delusion and positive confabulation are significantly related to the degree of present bias, but this is not the case for positive amnesia, contrary to the interpretation of Benabou and Tirole (2002). Moreover, we observe an intriguing relation between positive delusion and positive confabulation that individuals who do not exhibit delusion are less likely to have positive confabulation and individuals with positive confabulation are more likely to have positive delusion. The equilibrium behavior of our model is largely supported by our empirical findings.

The paper is organized as follows. Section 2 presents our theoretical model. Section 3 introduces our experimental design and discusses our empirical findings. Section 4 offers concluding remarks.

2 Model

We explore the possible motivational role of positive amnesia and delusion and study how their emergence depends on present bias and anticipatory utility, how delusion interacts with amnesia and contributes to the supply of over confidence. We apply Benabou and Tirole's (2002, hereafter B-T) approach in which individuals tend to have an under-investment problem due to their present-biased preferences. This leads to a demand of over confidence to resolve the insufficient motivation for investments. To account for our empirical findings of motivated false memory in the next section more fully, we extend the B-T model to a three-signal framework involving a good signal in addition to a bad signal and absence of signal.

At the outset, self-0 receives a private signal s concerning his ability θ. This may be a bad signal ($s = B$), no signal ($s = \emptyset$), or a good signal ($s = G$). At $t = 1$, he may mis-remember the nature of the signal received at $t = 0$. Here, no signal occurs with probability $1 - q$, bad signal occurs with probability qp, and good signal occurs with probability $q(1 - p)$. Thus, conditional on receiving a signal, the probability of it being bad is given by $p \in (0, 1)$ and being good is given by $1 - p$. Given feedback from reality, p represents the chance that the individual will face a negative event largely due to low ability.

We refer to the individual as type-B, type-$\emptyset$, or type-G corresponding to $s = B$, $\emptyset$, or G respectively. Let θ_s refer to the expected value of θ conditional on each possible realization of the true signal s, i.e., $\theta_B = E[\theta|s = B]$, $\theta_\emptyset = E[\theta|s = \emptyset]$ and $\theta_G = E[\theta|s = G]$.[10] Let

$$\theta_\emptyset = p\theta_B + (1 - p)\theta_G.$$

where $\theta_B < \theta_G$. That is, receiving no signal implies that his ability is given by the expected ability in the presence of a signal. Thus, $\theta_\emptyset$ lies in between θ_B and θ_G. In order to incorporate self-0's role in memory formation including the possibility of delusion for self-1, we let $\hat{s}$ denote the subjective signal transmitted from self-0 to self-1. Specifically:

(i) Good signal ($s = G$): In the absence of opportunity for signal manipulation, the transmitted signal $\hat{s} = G$, i.e., good signal.

(ii) Bad signal ($s = B$): The transmitted signal $\hat{s} = B$ (bad) or $\emptyset$ (empty). Self-0 may communicate the signal truthfully to self-1 or suppress the bad signal (*amnesia*). In Section 2.2, we develop our extended model to allow for changing a bad signal to a good one (*confabulation*). To have a controlled thought experiment, we abstract away from the possibility of confabulation here.

(iii) No signal ($s = \emptyset$): The transmitted signal $\hat{s} = \emptyset$ (empty) or G (good). Self-0 may leave an empty signal as it is or fabricate a fake good signal (*delusion*).[11]

Let $h_s = \Pr[\hat{s} = s|s]$ denotes the probability that he chooses to transmit the signal s truthfully to self-1 by self-0 of type s. We denote by h_B^* and $h_\emptyset^*$ the respective beliefs held by self-1 concerning self-0 being truthful in the individual's memory management strategy involving recall and delusion.

This intra-person game is depicted in Figure 1. At epoch 1, self-1 forms expectations over his ability θ in light of the recalled $\widehat{s}$, taking into account the possibility that self-0 may have suppressed the true signal or created a fake signal. Let $\theta^*(\widehat{s})$ denote self-1's assessment of his ability given $\widehat{s}$ and $r^*(\widehat{s})$ denote the reliability of

[10] Alternatively, we can simply assume that θ_s is the value of θ given the true signal s. Since the value of θ may be stochastic for a given s as discussed in Benabou and Tirole (2002), we take a more general interpretation of θ_s which represents the expected value of θ conditional on s.

[11] Our model only allows for memory biases in the positive direction, which can be justified by Result 1 and Result 2 in our experimental findings in the next section.

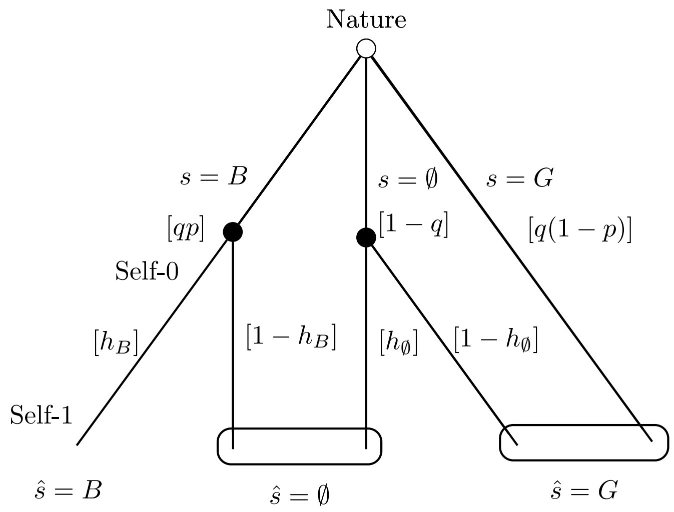

Figure 1: Memory management without confabulation

the signal $\widehat{s}$ given by the probability that the signal $\widehat{s}$ is accurate. We say that the individual exhibits *over confidence* when $\theta^*(\widehat{s}) > \theta_s$. Clearly, $\theta^*(B) = \theta_B$. For the case of recalling no-signal ($\hat{s} = \emptyset$), applying Bayes' rule, we have:

$$r^*(\emptyset) = \Pr[s = \emptyset | \hat{s} = \emptyset; h_B^*; h_\emptyset^*] = \frac{(1-q)\, h_\emptyset^*}{qp(1-h_B^*) + (1-q)\, h_\emptyset^*}.$$

It follows that

$$\theta^*(\emptyset) = r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B \geq \theta_B.$$

Similarly, for the case of recalling a good signal ($\hat{s} = G$), we have:

$$r^*(G) = \Pr[s = G | \hat{s} = G; h_B^*; h_\emptyset^*] = \frac{q(1-p)}{(1-q)\,(1-h_\emptyset^*) + q(1-p)},$$

and

$$\theta^*(G) = r^*(G)\theta_G + (1 - r^*(G))\theta_\emptyset > \theta_\emptyset.$$

The last inequality reflects strict over confidence of self-1 when there is no signal, because his updated belief $\theta^*(G)$ of his ability is always higher than the true ability $\theta_\emptyset$ of self-0 of type-$\emptyset$ when self-1 receives a good signal. However, his updated ability given no signal $\theta^*(\emptyset)$ equals θ_B when $h_\emptyset^*$ equals 0 so that $r^*(\emptyset) = 0$. In other words, the incidence of delusion precludes amnesia from delivering over confidence.

Self-1 will incur the cost of investment if and only if

$$\beta\theta^* V - c \geqslant 0$$

where V is the benefit from the investment for self-1, and c is the cost. The divergence in interest between self-0 and self-1 is captured by the incidence of present bias with $\beta < 1$ (Strotz, 1955; Laibson, 1997).

In the case of bad signal, self-0 chooses recall strategy h_B. The net gain from suppressing the bad signal is thus equal to:

$$\int_{\beta\theta_B V}^{\beta\theta^*(\emptyset)V} (\theta_B V - c)dF(c) + b[\theta^*(\emptyset) - \theta_B] \tag{1}$$

where F refers to the distribution function of c, $b > 0$ is the coefficient of anticipatory utility capturing the individual's affective/self-image concerns (Loewenstein, 1987; Benabou and Tirole, 2011).[12] A higher b implies a stronger sense of anticipatory feelings associated with self-image concerns. When $\theta^*(\emptyset)$ exceeds θ_B, amnesia delivers over confidence which in turn gives rise to more investment activities.

Similarly, for the case of no signal, self-0 chooses delusion strategy $h_\emptyset$. The net gain from creating a fake good signal is then given by:

$$\int_{\beta\theta^*(\emptyset)V}^{\beta\theta^*(G)V} (\theta_\emptyset V - c)dF(c) + b[\theta^*(G) - \theta^*(\emptyset)]. \tag{2}$$

Notice that $\theta^*(G)$ exceeds $\theta^*(\emptyset)$, so that delusion always delivers over confidence leading further to more investment activities.

Here, we apply the solution concept of perfect Bayesian equilibrium in conjunction with the intuitive criterion refinement (Cho and Kreps, 1987) to shed light on pure-strategy equilibrium outcomes of our memory management game.[13]

We have the following existence result of PBEs (see Appendix A.1 for proofs). In the absence of the possibility of confabulation, there are four possible perfect Bayesian equilibria in pure strategies.

Proposition 1 *(i) (Correct Recall) When b is small, there exists perfect Bayesian equilibrium, $h_B^* = 1$, $h_\emptyset^* = 1$ if $\beta > \beta_1(b)$ for some $\beta_1(b) \in (0,1)$; when b is large, this equilibrium does not exist.*

(ii) (Positive Amnesia) For p close to 1, when b is small enough, there exists perfect Bayesian equilibrium, $h_B^* = 0$, $h_\emptyset^* = 1$ if $\beta \in (\underline{\beta}_2(b), \overline{\beta}_2(b))$ for some $\underline{\beta}_2(b)$,

[12] For simplicity, we ignore the present bias of self-0 when calculating his expected utility.

[13] Under a uniform distribution, it is straightforward to solve the mixed strategy equilibiria explicitly. For simplicity, we do not consider mixed strategy equilibria in the balance of the paper.

$\overline{\beta}_2(b) \in (0,1)$*; for intermediate b, this equilibrium exists if* $\beta \in (\underline{\beta}_2(b), 1]$ *for* $\underline{\beta}_2(b) \in (0,1)$*; for large b, this equilibrium does not exist.*

(iii) (Positive Delusion) When b is small, there exists perfect Bayesian equilibrium, $h_\emptyset^* = 0$ *and* $h_B^* = 1$*, if* $\beta < \beta_3(b)$ *for some* $\beta_3(b) \in (0,1]$*; when b is large, this equilibrium always exists.*

(iv) (Positive Delusion with Amnesia) For p close to 1 *and b is small, there exists perfect Bayesian equilibrium,* $h_\emptyset^* = 0$ *and* $h_B^* = 0$*, if* $\beta < \beta_4(b)$ *for some* $\beta_4(b) \in (0,1]$*; when b is large, this equilibrium always exists.*

In case (i) where anticipatory concern is limited (b small enough) and present bias is not severe (β large enough), there is an equilibrium with perfect recall and no delusion. Otherwise, amnesia or delusion would create a bias towards over-investment of self-1 from the perspective of self-0. In case (ii), the amnesia condition requires β to be bounded from above while no-delusion requires β to be bounded from below. In case (iii), we have delusion without amnesia, while, in case (iv), we have delusion with amnesia. When present bias and anticipatory utility are sufficiently severe, self-0 of type-B and type-$\emptyset$ will both cheat. Nonetheless, the equilibrium outcome of case (iii) is similar to case (iv). There is no actual amnesia in equilibrium because when self-1 receives no signal, he knows that he is of type-B. While delusion and amnesia can act as substitutes as motivational mechanisms to supply over confidence, delusion precludes amnesia from delivering over confidence in this equilibrium. In this sense, the amnesia in case (iv) is fake.

Moreover, we observe the following relations between thresholds of present bias and the degree of anticipatory utility.

Observation 1 *The thresholds* $\beta_1(b)$*,* $\underline{\beta}_2(b)$*,* $\overline{\beta}_2(b)$*,* $\beta_3(b)$*,* $\beta_4(b)$ *are increasing in b.*

A higher degree of anticipatory utility will lower the requirement of present bias to satisfy the condition for the existence of false memory equilibria. Thus, present bias and anticipatory utility are two sources of motivated false memory, and are thus substitutes to each other in inducing memory errors.

Our simple mechanism on how the functional role of positive amnesia can be invalidated by positive delusion gives rise to the following relation between positive delusion and present bias or anticipatory utility.

Corollary 1 *In the absence of the possibility of confabulation, when the degree of anticipatory utility is sufficiently low, the likelihood of positive delusion increases in the degree of present bias, but this is not the case for positive amnesia.*

This corollary offers an account for Result 4 and Result 5 in the following section. In contrast with the B-T interpretation, the existence of the equilibrium with amnesia does not depend monotonically on the magnitude of present bias due to the possibility of fake amnesia in case (iv). Similarly, when the present bias is not severe, the likelihood of positive delusion increases in the degree of anticipatory utility, but this is not the case for positive amnesia.

2.1 Robustness

Partial naivete

Our baseline model assumes that individuals have perfect self-awareness, and thus engage in full extent of self-doubt in equilibrium. Following the B-T practice, we assume that individuals are aware of memory manipulation, but underestimate the degree by imperfect Bayesian updating. Specifically, if self-1 receives an empty signal $\hat{s} = \emptyset$, its reliability can be revised as

$$r^*(\emptyset) = \Pr[s = \emptyset | \hat{s} = \emptyset; h_B^*; h_\emptyset^*] = \frac{(1-q)\, h_\emptyset^*}{\pi q p (1 - h_B^*) + (1-q)\, h_\emptyset^*}.$$

Similarly, the reliability of good signal $\hat{s} = G$ for self-1 can be rewritten as

$$r^*(G) = \Pr[s = G | \hat{s} = G; h_B^*; h_\emptyset^*] = \frac{q(1-p)}{\pi\,(1-q)\,(1-h_\emptyset^*) + q(1-p)}.$$

Here, $\pi \in (0, 1]$ represents cognitive sophistication level, and $\pi < 1$ captures partial naivete. Partial naivete lets memory manipulation be less costly, thus making all the false memory equilibria more likely to exist. In case (iv) of Proposition 1, we have $h_B^* = 0$ and $h_\emptyset^* = 0$. In this case, as long as the individual is not completely naivete ($\pi \neq 0$), the reliability of empty signal is always 0, i.e., the functional value of amnesia is still invalidated by delusion by allowing for partial naivete.

Costly memory manipulation

Our baseline model also assumes that individuals do not incur any cost of memory manipulation. Now we allow the cost functions of amnesia and delusion to be $M_a(h_B^*)$ and $M_d(h_\emptyset^*)$ respectively. Let $\overline{M_a} \equiv M_a(0) - M_a(1) > 0$ and $\overline{M_d} \equiv M_d(0) - M_d(1) > 0$, capturing costly memory manipulation. For analytic simplicity, we also assume that c is uniformly distributed over $[0, \overline{c}]$ where $\overline{c}$ is sufficiently large. Then the net values of amnesia and delusion can be rewritten as

$$\frac{1}{\overline{c}} \int_{\beta\theta_B V}^{\beta\theta^*(\emptyset)V} (\theta_B V - c)dc + b[\theta^*(\emptyset) - \theta_B] - \overline{M_a} \tag{3}$$

and

$$\frac{1}{\overline{c}} \int_{\beta\theta^*(\emptyset)V}^{\beta\theta^*(G)V} (\theta_\emptyset V - c)dc + b[\theta^*(G) - \theta^*(\emptyset)] - \overline{M_d}. \tag{4}$$

When the costs of memory manipulation are small compared to the degree of anticipatory feelings, i.e., $\overline{M_a} < b[\theta^*(\emptyset) - \theta_B]$ and $\overline{M_d} < b[\theta^*(G) - \theta^*(\emptyset)]$, our key results keep robust. However, when it is not the case, we observe that the positive cost of memory manipulation may change the equilibrium behavior qualitatively. For example, in the benchmark model when $b = 0$, for a severe present bias, there always exists perfect Bayesian equilibrium of positive delusion, since the benefit from over confidence which alleviates future self's under investment problem outweighs the cost from over investment. In the presence of memory manipulation cost, however, the perfect Bayesian equilibrium of positive delusion may disappear. From equation (4), we can find that when present bias is extremely severe, the benefit from signal manipulation shrinks and even reaches to zero when $\beta = 0$, while the cost is still positive. Moreover, when the cost of delusion is higher than that of amnesia, the monotonicity of false memory in terms of present bias may also fail. We summarize the detailed results in Proposition 3 listed in Appendix A.3.

2.2 Extended Model with Confabulation

The baseline model provides us the key insight on how positive amnesia and delusion can supply over confidence and how the emergence of positive delusion invalidates the function of positive amnesia. A natural extension is to incorporate the possibility of positive confabulation, which is defined as transmitting the bad signal into a good signal. There are two potential mechanisms to include the possibility of confabulation: transforming the bad signal ($s = B$) into a good signal ($\hat{s} = G$) directly (one-step model) or forgetting the bad signal first and generating a good signal then (two-step model). The implication of the one-step model is inconsistent with our experimental findings, the detailed analysis of which is listed in Appendix A.4.

Here, we posit a two-step model of memory management. The memory management strategy involves four epochs: $t = 0, t = 0^+, t = 1$, and $t = 2$. At $t = 0$, the individual chooses his memory management strategy after receiving a signal about his ability. At $t = 0^+$, the individual applies his memory management strategy again to the reported signal and further chooses how to transmit this reported signal – truthfully or deceptively. We also assume that the individual has impefect recall (Piccione and Rubinstein, 1997) in the sense that he cannot distinguish between s and $\hat{s}$ and thus cannot verify at which stage he is making decisions. At $t = 1$, he decides whether to engage in the activity which delivers a payoff at $t = 2$.

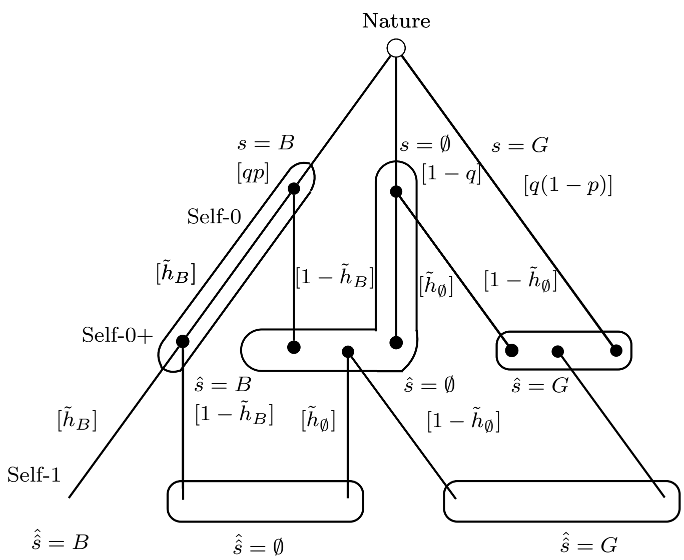

Figure 2: Memory management with two-step confabulation

Figure 2 displays our two-step motivated false memory model. Based on self-0's signal or self-0^+'s memory, when $s = \hat{s} = B$, he can choose to recall it with probability $\tilde{h}_B$ or forget it with probability $1-\tilde{h}_B$. When $s = \emptyset$ or $\hat{s} = \emptyset$, he can choose to transmit it truthfully to self-1 with probability $\tilde{h_\emptyset}$ or exhibit delusion with probability $1 - \tilde{h_\emptyset}$. Accordingly, we define the reported signal transmitted from self-0^+ to self-1 as $\hat{\hat{s}}$. As before, self-1 will decide whether to undertake the task according to his belief about his ability.

Following the preceding analysis, we can identify four possible PBEs (see Appendix A.5 for proofs).

Proposition 2 *(i) (Correct Recall) When b is small, there exists perfect Bayesian equilibrium, $\tilde{h}^*_B = 1$, $\tilde{h}^*_\emptyset = 1$ if $\beta > \tilde{\beta}_1(b)$ for some $\tilde{\beta}_1(b) \in (0, 1)$.*

(ii) (Positive Amnesia) For p close to 1, when b is small, there exists perfect Bayesian equilibrium, $\tilde{h}^*_B = 0$, $\tilde{h}^*_\emptyset = 1$ if $\beta > \tilde{\beta}_2(b)$ for some $\tilde{\beta}_2(b) \in (0, 1)$.

(iii) (Positive Delusion) When b is small, there exists perfect Bayesian equilibrium, $\tilde{h}^*_B = 1$ and $\tilde{h}^*_\emptyset = 0$, if $\beta \in (\tilde{\underline{\beta}}_3(b), \tilde{\overline{\beta}}_3(b))$ for some $\tilde{\underline{\beta}}_3(b)$, $\tilde{\overline{\beta}}_3(b) \in (0, 1)$; for intermediate b, this equilibrium exists if $\beta \in (\tilde{\underline{\beta}}_3(b), 1]$ for $\tilde{\underline{\beta}}_3(b) \in (0, 1)$.

(iv) (Positive Confabulation with Delusion) When b is small, there exists perfect Bayesian equilibrium, $\tilde{h}^*_B = 0$ and $\tilde{h}^*_\emptyset = 0$, if $\beta < \tilde{\beta}_4(b)$ for some $\tilde{\beta}_4(b) \in (0, 1]$.

From the above proposition, it is apparent that when b is small, there is no monotonic relation between present bias and positive amnesia. At the same time, it is clear that positive delusion and positive confabulation both relate positively to the degree of present bias, as stated formally below.

Corollary 2 *In the two-step false memory model with the possibility of confabulation, when the degree of anticipatory utility is sufficiently low, the likelihood of both positive delusion and positive confabulation increases in the degree of present bias. This is not the case for positive amnesia.*

This two-step motivated false memory model suggests that present bias leads to positive delusion and positive confabulation but not positive amnesia; it also suggests that delusion is the only channel to supply confabulation, which are largely confirmed by the Result 3 of our experimental results.

3 Experiment

We conduct an experiment in Singapore to study three kinds of memory errors (amnesia, delusion and confabulation) on IQ performance and relate them to a range of preferential attitudes including time, anticipatory feelings related to self-image concern, risk and ambiguity, followed by a replication of this experiment in Beijing.

3.1 Design

In the first stage of our experiment, subjects' discount rates are elicited from comparisons between their tradeoffs in a proximal task (next day versus 31 days later) and a distal task (351 days versus 381 days later). In addition, we measure subjects' attitudes of timing of experiencing positive or negative events as a proxy of anticipatory utility, risk and ambiguity attitudes and have them complete an incentivized Ravens IQ test (see Appendix B). In the second stage after months, we elicit different types of memory errors based on their recall of performance in the IQ test in an incentivized setting. Of subjects from Singapore (main sample) and Beijing (replication sample) participating in the experiment, 1158 and 668 subjects participate in the first stage of the experiment, among whom 701 and 445 subjects complete both stages of our study. Thus, the attrition rates are 39% and 33% respectively. Among 445 subjects of Beijing sample, 3 subjects' numbers of correct answers of IQ test equal to 7, 9 and 15 respectively. Considering that the average score of IQ test is over 55 for the whole sample and the lowest scores of Singapore sample and the other subjects in Beijing sample are both 32, we drop these 3 samples as unreasonable responses, so the valid sample sizes are 701 and 442 respectively. The show-up fees are S$35 for subjects in Singapore and RMB140 for those in Beijing.

In the subsequent stage, subjects are shown 6 test questions one at a time together with the correct answers. Of the 6 questions, 4 appeared in the initial stage and 2 are new. For all subjects, all 6 questions are identical but the order of appearance is randomized. For each of these 6 questions, subjects can choose one of 4 responses:

- a : My response was correct.
- b : My response was incorrect.

- c : I didn't see this question.
- d : I don't remember.

For the 4 questions which had appeared previously, subjects from our main sample in Singapore receive S$1 and those from our replication sample in Beijing receive RMB5 if their choice reflects correctly their performance or if they choose (c) for the 2 questions which had not appeared previously. The subject loses S$1 or RMB5 when his/her choice reveals an error of delusion or confabulation. Subjects always receive nothing if they choose (d) – "I don't remember".

For each of the 6 questions presented in the second stage, the subject either did it right ($s = G$), did it wrong ($s = B$), or did not see it ($s = \emptyset$) at the initial stage. The table below displays the definition of memory patterns according to subjects' performance in first stage and possible responses in second stage.

			Recall in Second Stage			
			a. I did it right	b. I did it wrong	c. I didn't see it	d. I don't remember
			$\hat{s} = G$	$\hat{s} = B$	$\hat{s} = \emptyset$	
Performance in First Stage	Old Question	$s = G$	a_G: Correct Recall	b_G: Negative C	c_G: Negative A	d_G: Weak Negative A
		$s = B$	a_B: Positive C	b_B: Correct Recall	c_B: Positive A	d_B: Weak Positive A
	New Question	$s = \emptyset$	$a_\emptyset$: Positive D	$b_\emptyset$: Negative D	$c_\emptyset$: Correct Recall	$d_\emptyset$: Weak Correct Recall

Table 1: Definitions of Memory Patterns

There are three types of correct recall (CR), a_G, b_B, and $c_\emptyset$, denoting reporting the performance correctly for the four old questions appeared in first stage and reporting empty memory for the new questions. Moreover, compared to $c_\emptyset$ (recalling correctly that one has not seen the question previously), $d_\emptyset$ (choosing "I don't remember" when one has not seen the question before) reveals a weak sense of correct recall. There remains 8 types of memory errors: two linked to delusion (D), $a_\emptyset$ and $b_\emptyset$, which denote the case where the subject remembered a new question incorrectly; two linked to confabulation (C), a_B and b_G, which means that the subject misremembered his/her performance with respect to a question which had appeared previously. In terms of amnesia (A), when the question had appeared before, stating "I don't remember" (option (d)) is weaker than claiming "I didn't see this question" (option (c)). Thus, we denote d_G and d_B as weak amnesia compared with c_G and c_B as amnesia. Given the parallel between responses in (c) and the responses in (d), we have grouped them together in our data analysis.

3.2 Results

We report the findings of our incentivized experiment on different types of memory errors and their relation to temporal discounting and some other personal traits such as anticipatory feelings related to self-image concern, risk preference, gender, etc.

3.2.1 Memory Errors

The overall memory patterns of main sample in Singapore (see Table 4 in Appendix C.1) reveal considerable incidence of amnesia (33.95%), delusion (64.12%), and confabulation (10.63%) relative to all the possibilities. In each case, we find a consistent tendency for a positive bias which we shall detail below.

Figure 3a displays the respective rates of positive amnesia $(c_B+d_B)/(a_B+b_B+c_B+d_B)$ for Question 1 to Question 4 at 48.39%, 50.00%, 49.35% and 41.20%, which are significantly higher than the corresponding rates of negative amnesia $(c_G+d_G)/(a_G+b_G+c_G+d_G)$ at 29.93%, 30.98%, 29.79% and 27.34% (see Table 7). In other words, individuals who did a question incorrectly are significantly more likely to forget than those who did the question correctly.

In summary, we have the following result of positive amnesia.

Result 1 *Individuals tend to exhibit positive amnesia rather than negative amnesia.*

Figure 3b displays the rate of positive delusion $a_\emptyset/(a_\emptyset+b_\emptyset+c_\emptyset+d_\emptyset)$ and negative delusion $b_\emptyset/(a_\emptyset+b_\emptyset+c_\emptyset+d_\emptyset)$. The rates of positive delusion for Question 5 and Question 6 are respectively 56.21% and 62.62% and the rates of negative delusion are 4.28% and 5.14%. The conditional proportions of positive delusion $a_\emptyset/(a_\emptyset+b_\emptyset)$ are 92.92% and 92.42% in comparison with the base rates of correct response for questions 1 to 4: 86.73%, 82.88%, 67.05% and 59.49% (as shown in Table 10). Compared with

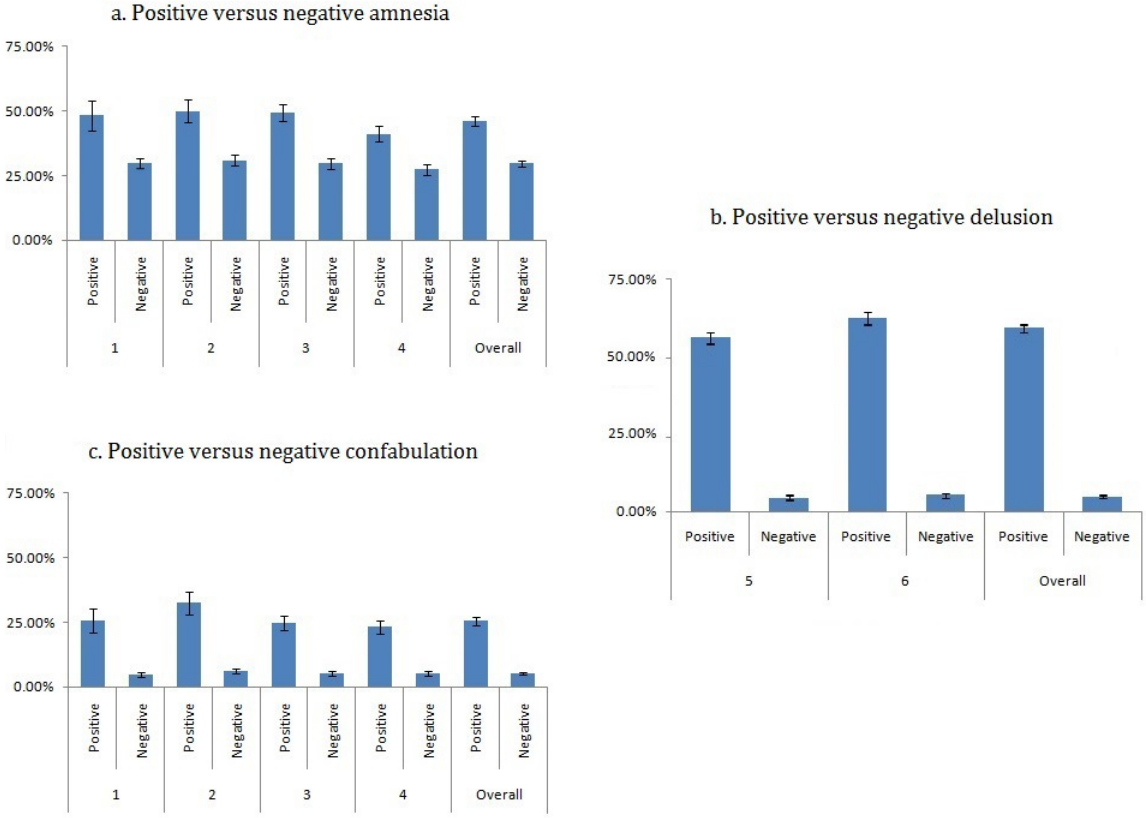

Figure 3: Patterns of memory bias (main sample)

Question 1, the rates of positive delusion for questions 5 and 6 are significantly higher than the base rate (respectively $p = 0.0006$ and $p = 0.0011$). All the other p-values are at the 0.0000 level. Taken together, the pattern of delusion exhibits a significant positive tendency relative to the actual base rates of correct response.

According to Table 4 in Appendix C.1, 25.55% of those who did it incorrectly in the first stage exhibit positive confabulation. As observed earlier, this is not compatible with our basic model. Figure 3c displays the respective rates of positive confabulation $a_B/(a_B+b_B+c_B+d_B)$ for Question 1 to Question 4 at 25.81%, 32.50%, 24.68% and 23.24%, which are significantly greater than the corresponding rates of negative confabulation $b_G/(a_G+b_G+c_G+d_G)$ at 4.93%, 6.02%, 5.32% and 5.28% (see Table 7).

Summarizing, we have the following result where false memory refers to both delusion and confabulation.

Result 2 *Individuals tend to exhibit positive false memory including positive delusion and positive confabulation rather than negative false memory.*

Our modeling setup of the positive direction of memory management is consistent with Result 1 and Result 2 where subjects tend to have only positive amnesia, positive delusion and positive confabulation. To check the pattern of memory biases such as the relation between positive delusion and positive confabulation, we next observe:

Result 3 *Individuals who do not exhibit positive delusion are less likely to have positive confabulation; individuals with positive confabulation are more likely to have positive delusion.*

This result (see Table 13) describes the relationship between positive delusion and positive confabulation. Among 210 subjects out of 701 who do not exhibit positive delusion, the rates of positive confabulation of 26.67%, 42.86%, 36.67% and 25.71% for these four questions are significantly lower than the corresponding rates of unconditional positive confabulation of 50.00%, 65.00%, 48.72% and 39.52% at p-values of 0.058, 0.065, 0.1202 and 0.0627 respectively. Correspondingly, among 145 subjects who exhibit some positive confabulation, their rates of positive delusion (73.19% and 78.36%) are significantly higher than the corresponding unconditional rates of positive delusion of 58.72% and 66.02% at p-values of 0.0007 and 0.0026 respectively. In sum, individuals who do not exhibit delusion are less likely to have positive confabulation while individuals with positive confabulation are more likely to have positive delusion. Taken together, these findings suggest that positive delusion may be an intermediate step in a process leading to positive confabulation. While Proposition 2 in the two-step model in our general theory below fits naturally into this result, we are not aware of any paper in the existing literature on memory management providing the explanation. This two-step confabulation process appears to be related to the idea of Korsakoff Syndrome (Whitty and Lewin, 1960) in which confabulation can be considered to serve as compensatory pseudo-reminiscence to fill the memory gap. In other words, the brain can produce false memory to make up for memory loss. Proposition 4 in the one-step model listed in Appendix A.4 cannot account for this result.

All the qualitative results above are robust in the replication sample in Beijing and the pooled sample (including both Singapore and Beijing). We display them in Figure 5, Figure 6 and relegate the details to Table 5, 6, 8, 9, 11 and 12 in Appendix C.

3.2.2 Present Bias, Anticipatory Feelings and Memory Bias

When a subject does not recall whether he has seen a specific question previously, choosing (a), (b), or (c) entails some degree of downside risk or ambiguity. From this perspective, option (d) is free of risk or ambiguity. Before studying the implications of our model relating positive memory biases to the degree of present bias and anticipatory feelings, we first examine whether the frequency of choosing (d) is related to risk attitude and ambiguity attitude measured using two incentivized tasks (see Appendix B.2 and B.3). We run an ordered probit regression on the number of (d) choice, $\#d$ (from 0 to 6), with regressors β, δ, *paf*, *naf*, *pur*, *nur*, *ra*, *aa*, *female*, *duration* and *Singapore*. β is the ratio of the switch point of proximal task to that of distal task and δ is the switch point in distal task (normal discount rate). *paf* and *naf* indicate the subjects' willingness to experience certainty events now or in the future (1: now; 2: future), and *pur* and *nur* indicate the tendency of the subjects to resolve some uncertain events associated with self-image concern (1: now; 2: future), where *paf* and *pur* refer to good events and *naf* and *nur* refer to bad events. *ra* (from 0 to 10) refers to the observed degree of risk aversion in a portfolio choice task, *aa* (from -10 to 10) refers to the degree of ambiguity aversion, *female* equals 1 if the subject is female and 0 otherwise, *duration* is the number of days between two stages, and *Singapore* equals 1 indicating main sample from Singapore and 0 indicating replication sample from Beijing. We list the summary statistics in Table 2.

Table 2: Summary statistics for main variables

Main Variables	Mean	SD	Min	Max
female	0.4899211	0.5001176	0	1
Singaporean	0.6116928	0.4875778	0	1
age	21.45896	1.978984	16	29
IQ	55.67367	3.546943	32	60
β	0.9757845	0.0802975	0.78125	1.28
δ	0.9460945	0.0709866	0.78125	1
paf	1.768893	0.4217262	1	2
naf	1.259227	0.4384029	1	2
pur	1.515364	0.4999834	1	2
nur	1.608963	0.4881972	1	2
ra	5.428705	2.392229	1	10
aa	2.216216	3.155462	-10	10

We do find a significant negative relation between $\#d$ with IQ which corroborates the general finding of a positive relation between IQ and accuracy of recall ($p = 0.000$). We also find a significant difference between two groups ($p = 0.000$). The main sample are more likely to choose option (d). The absence of a significant relation between $\#d$ and *duration* reveals that time difference does not play an important role in our memory test ($p = 0.976$). There is no significant relation between $\#d$ and subjects' risk attitude, ambiguity attitude, or gender. While the estimated coefficients for *ra* is negative, it is not significantly different from zero ($p = 0.121$).

In studying the influence of present bias, we first focus on positive memory biases based on subjects' recall of their performance on Question 1 to Question 4. Consider the subject's behavior for positive amnesia which applies when he did a question incorrectly. We define a binary variables h_B to indicate subjects' recall behavior when his IQ answer was incorrect. If he correctly recalls his performance in the second stage, i.e., choosing (b), the recall behavior is $h_B = 1$. If he cannot recall his initial performance or he does not remember having seen this question, i.e., choosing (c) or (d), we interpret this as positive amnesia with recall behavior $h_B = 0$. We run a probit regression on h_B with regressors β, δ, *paf*, *naf*, *pur*, *nur*, *ra*, *aa*, *female*, *duration* and *Singapore*.

Result 4 *Positive amnesia is not related to the degree of present bias.*

The estimated coefficients for β in questions 1 to 4 are of different signs and are individually not significant. Pooling them together, the result is still not significant. Thus amnesia does not have a significant probit relation with present bias. Moreover, two groups (Singapore and Beijing) do not exhibit significant difference on positive amnesia (see Appendix C.6 for more details on the regression result of the positive amnesia part). Furthermore, we observe significantly positive relation between positive amnesia and *paf* for Question 2 ($p = 0.097$).

We then examine the subject's behavior for positive delusion with the two new questions – Question 5 and Question 6. If he indicates that he did it correctly, the delusion behavior is $h_\emptyset = 0$. Otherwise, if he indicates that this question may be new, i.e., answer (c) or (d), his delusion behavior is $h_\emptyset = 1$. We run a probit regression on $h_\emptyset$ using the regressors β, δ, *paf*, *naf*, *pur*, *nur*, *ra*, *aa*, *female*, *duration* and *Singapore*. Next, we consider the subject's behavior for positive confabulation when he did a question incorrectly. If he indicates that he did it correctly, i.e., choosing (a), the confabulation behavior is $h'_B = 0$ which we interpret as positive confabulation. If he can recall his performance correctly, i.e., choosing (b), the confabulation behavior is $h'_B = 1$. Summarizing:

Result 5 *The likelihood of individual having positive false memory including positive delusion and positive confabulation increases in the degree of present bias (β lower).*

Regarding positive delusion, for both Question 5 and 6, the signs of the estimated coefficients for β are consistent with Proposition 1 and most of them are significant (except column (6), (7), (8), (9), and (11) for Question 5). Pooling Question 5 and Question 6, the coefficients of β in all columns are significant. Regarding positive confabulation, the coefficients of β in all the columns for Question 2 and 4 and most columns for Question 1 are significant with positive signs. For Question 3, the coefficients are not significant. Pooling four questions together, the result remains significant in all the columns. Moreover, we find that subjects in the replication sample from Beijing are more likely to exhibit positive delusion and positive confabulation. (see Appendix C.6 for more details on the regression results of positive delusion and positive confabulation).

Meanwhile, we observe certain relations between positive memory biases and anticipatory feelings. We find significantly positive relation between positive amnesia and anticipatory feeling *paf* for Question 2. For positive delusion, we observe significantly positive relation with *paf* in some columns for Question 5. For positive confabulation, we find that it has significantly positive relations with *paf* and *pur* for Question 2. The directions are consistent with the theoretical implications yet with limited magnitude.

Furthermore, we can rule out two potential explanations relating to positive amnesia. One explanation is based on the idea that having opportunities for mental rehearsal can improve recall, in which case positive amnesia can result if answering correctly engenders more opportunities for rehearsal than answering incorrectly. However, this explanation cannot account for the significant incidence of positive memory bias when facing new questions in Stage 1 in the absence of opportunities for rehearsal. Another explanation may lie in our subjects, who are generally smart, choosing "My response was correct" if they think they can remember. While this explanation can explain positive amnesia, it cannot account for the observed relations between memory biases and the other factors, particularly present bias, examined in the experiment.

4 Concluding Remarks

Memory errors may play an affective role in daily life, a functional role in business activity or both roles in cultural transmission. Our paper reflects an active interplay between experimental observation and theory development to understand the widely documented phenomena of imperfect recall and false memory, and how they may relate to individual traits including time preference, risk and ambiguity attitudes and psychological features such as anticipatory feelings. We aim to investigate why and how individuals are cognitively "biased", and tend to find the link of these aspects of psychological regularities. A few issues are worth discussing.

Measure of memory failure: Memory is a dynamic mechanism of storing, retaining and retrieving information about the past experience (Bjorklund, Schneider and Hernandez Blasi, 2003; Roediger and Crowder, 1976). There are mainly two methods to measure explicit memory: recall or recognition.[14] For recall tasks, relatedly, a few studies show that people remember events that never happened (e.g., Bartlett, 1932; Bransford and Franks, 1971; Roediger and McDermott, 1995) and people create false memory via suggestions, distorted by the way the questions are asked (Loftus and Pickrell, 1995; Loftus and Palmer, 1996). Our experiment involves the recognition task. Compared to the standard memory task in the literature, we focus on positive/negative direction of false memory from the viewpoint of constructive nature of memory such as positive autobiographical memory (Davis and Loftus, 2007; Grant and Ceci, 2000; Sutton, 2003).

Inattention or memory failure? One may wonder how we separate measuring memory from inattention, which is regarded as a basic challenge in psychology. Did the subjects forget or did they not notice in the first place? In our experiment, however, all IQ questions are incentivized. The success rates of four IQ questions (86.73%, 82.88%, 67.05% and 59.49%) suggest sufficient incentives for the subjects to pay attention to the IQ questions. Nonetheless, our model actually does not distinguish between inattention and memory error such as amnesia (loss of explicit memory), and thus allow for both interpretations. No matter changing a negative event into an empty one is interpreted as amnesia or inattention, we observe the relation between the degree of present bias and the tendency of changing signals in

[14] In explicit memory tasks, subjects engage in conscious recollection of past experience, while subjects use information from implicit memory without being consciously aware of it (Berry, Shanks and Henson, 2008; McBride, 2007).

the laboratory, consistent with our theory.

Conscious or unconscious memory management: Introspection suggests that human being cannot consciously choose to forget or be delusional. Yet, while memory bias including false memory is inherently not a conscious process, they tend to possess directionality in terms of a tendency to forget bad signals as well as to fantasize positively. At the same time, we do observe people engaging consciously in specific acts to facilitate their forgetting certain bad signals, e.g., leaving a place to avoid bad memories or burning photos of ex-spouses, and also to induce fake but good signals, such as addiction to soap operas or obsession with video games, possibly to enhance one's self image. Notably, in a review paper, Howe's (2011) suggestion of adaptive functionality in delusional disposition corroborates our overall finding of positive amnesia and positive false memory. As such, we posit that memory choice including amnesia and false memory is generally made nonconsciously, but conscious memory management is still observed in practice. Our findings both theoretically and experimentally allow for forgetting bad signals and romanticizing fake signals that echo the empirical observations as reported in McKay and Dennett (2009), Howe and Derbish (2010) and Howe et al. (2011).

Collectivist interpretation: Our three-signal extension of the B-T model admits a natural reinterpretation in a multi-person setting requiring no substantive change in the game form. Benabou (2013) investigates bias in collective memory and its function in forming social cognition, and shows that collective delusion in terms of denial of information may be contagious in societies, generating multiple social cognitions. Such a reinterpretation of our model can provide a rationale for the motivational value of myth making, e.g., telling tales to induce children to form a more rosy view of the world corresponding to a belief in an enhanced chance of future happiness. Our theory suggests that tale telling may conceivably be more functional than omitting information such as a lack of academic achievements. In this case, self-0 represents the older generation while self-1 refers to the younger generation. Besides present bias at the individual level, the β parameter may also capture a degree of altruism of the current generation towards the future generation. Closest to our collectivist reinterpretation is the work by Dessi (2008) who studies collective memory and cultural transmission, and explains how information suppression at the societal level alleviates the free riding problem. Moreover, our model with confabulation can offer an account for collective confabulation in transforming past disastrous events into myths, legends, and Utopian tales to be transmitted across generations. Our approach can give rise to a fresh take on how institutional fabrication including collective amnesia, collective delusion, and collective confabulation can enhance confidence at the societal level, thereby motivating people to invest in the collective good from the perspective of the older generations.

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Appendix

A Proofs

A.1 Proof of Proposition 1

(i) Correct Recall ($h_B^* = 1$, $h_\emptyset^* = 1$): We have $r^*(\emptyset) = 1$ and $r^*(G) = 1$. When $s = B$, define:

$$\begin{aligned}\chi[r^*(\emptyset), \beta, b] &= \int_{\beta\theta_B V}^{\beta\theta^*(\emptyset)V} (\theta_B V - c)dF(c) + b[\theta^*(\emptyset) - \theta_B] \\ &= \int_{\beta\theta_B V}^{\beta\theta_\emptyset V} (\theta_B V - c)dF(c) + b(\theta_\emptyset - \theta_B).\end{aligned} \tag{5}$$

Let

$$b_1' \equiv \frac{\int_{\theta_B V}^{\theta_\emptyset V}(c - \theta_B V)dF(c)}{\theta_\emptyset - \theta_B}.$$

Notice that when $b \in [0, b_1')$, $\chi[r^*(\emptyset), 1, b] < 0$ and that $\chi[r^*(\emptyset), \beta, b] > 0$ for $\beta \in (0, \theta_B/\theta^*(\emptyset)]$.

It follows that there exists $\beta'(b) \in (\theta_B/\theta^*(\emptyset), 1)$ such that $\chi[r^*(\emptyset), \beta', b] = 0$. Moreover, $\chi[r^*(\emptyset), \beta, b]$ is positive for $\beta \in (0, \beta'(b))$ and negative for $\beta \in (\beta'(b), 1)$, and

$$\frac{\partial\chi[r^*(\emptyset), \beta, b]}{\partial\beta} = \theta^*(\emptyset)V^2[\theta_B - \beta\theta^*(\emptyset)]f[\beta\theta^*(\emptyset)V] - \theta_B V^2[\theta_B - \beta\theta_B]f(\beta\theta_B V) < 0,$$

for $\beta \in [\theta_B/\theta^*(\emptyset), 1]$. Therefore, $h_B^* = 1$, if $\beta > \beta'(b)$. When $b \in [b_1', +\infty)$, $\chi[r^*(\emptyset), \beta, b]$ is always positive for any β, thus h_B^* can never reach 1.

When $s = \emptyset$, we can similarly define:

$$\begin{aligned}\Psi[r^*(\emptyset), r^*(G), \beta, b] &= \int_{\beta\theta^*(\emptyset)V}^{\beta\theta^*(G)V} (\theta_\emptyset V - c)dF(c) + b[\theta^*(G) - \theta^*(\emptyset)] \\ &= \int_{\beta\theta_\emptyset V}^{\beta\theta_G V} (\theta_\emptyset V - c)dF(c) + b(\theta_G - \theta_\emptyset).\end{aligned} \tag{6}$$

We have that $\Psi[r^*(\emptyset), r^*(G), 1, b] < 0$ and $\Psi[r^*(\emptyset), r^*(G), \beta, b] > 0$ for $\beta \in (0, \theta_\emptyset/\theta_G]$. Let

$$b_1'' \equiv \frac{\int_{\theta_\emptyset V}^{\theta_G V}(c - \theta_\emptyset V)dF(c)}{\theta_G - \theta_\emptyset}.$$

Thus, when $b \in [0, b_1'')$, $\Psi[r^*(\emptyset), r^*(G), \beta''] = 0$ for some $\beta''(b) \in (\theta_\emptyset/\theta_G, 1)$. Moreover, $\Psi[r^*(\emptyset), r^*(G), \beta, b]$ is positive for $\beta \in (0, \beta''(b))$ and negative for $\beta \in (\beta''(b), 1)$, and

$$\frac{\partial\Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial\beta} = \theta_G V^2[\theta_\emptyset - \beta\theta_G]f(\beta\theta_G V) - \theta_\emptyset V^2[\theta_\emptyset - \beta\theta_\emptyset]f(\beta\theta_\emptyset V) < 0,$$

for $\beta \in [\theta_\emptyset/\theta_G, 1]$. Thus, $h^*_\emptyset = 1$, if $\beta > \beta''(b)$. When $b \in [b''_1, +\infty)$, $\Psi[r^*(\emptyset), r^*(G), \beta, b]$ is always positive for any β, thus $h^*_\emptyset$ can never reach 1. It follows that a correct recall PBE ($h^*_B = 1$, $h^*_\emptyset = 1$) exists for $\beta > \max\{\beta'(b), \beta''(b)\} \equiv \tilde{\beta}_1(b)$ when $b < \min\{b'_1, b''_1\}$.

(ii) Positive Amnesia ($h^*_B = 0$, $h^*_\emptyset = 1$): We have $r^*(\emptyset) = (1-q)/(qp+1-q)$ and $r^*(G) = 1$. When $s = B$,

$$\chi[r^*(\emptyset), \beta, b] = \int_{\beta\theta_B V}^{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V} (\theta_B V - c)dF(c) + b\frac{1-q}{qp+1-q}(\theta_\emptyset - \theta_B).$$

Let

$$b'_2 \equiv \frac{\int_{\theta_B V}^{(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}(c - \theta_B V)dF(c)}{\frac{1-q}{qp+1-q}(\theta_\emptyset - \theta_B)}.$$

As in the proof of existence of PBE1, when $b \in [0, b'_2)$, there exists $\overline{\beta}_2(b)$ such that $\chi[r^*(\emptyset), \beta, b] > 0$ for $\beta \in (0, \overline{\beta}_2(b))$ and $\chi[r^*(\emptyset), \beta, b] < 0$ for $\beta \in (\overline{\beta}_2(b), 1)$. It follows that $h^*_B = 0$ if $\beta < \overline{\beta}_2(b)$; when $b \in [b'_2, +\infty)$, $\chi[r^*(\emptyset), \beta, b]$ is always positive. When $s = \emptyset$,

$$\Psi[r^*(\emptyset), r^*(G), \beta, b] = \int_{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\beta\theta_G V} (\theta_\emptyset V - c)dF(c) + b\frac{p}{qp+1-q}(\theta_G - \theta_B).$$

Let

$$b''_2 \equiv \frac{\int_{(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\theta_G V}(c - \theta_\emptyset V)dF(c)}{\frac{p}{qp+1-q}(\theta_G - \theta_B)}.$$

If we have

$$\int_{(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\theta_G V} (\theta_\emptyset V - c)dF(c) < 0,$$

i.e., p is close to 1, we can similarly conclude that when $b \in [0, b''_2)$, there is a $\underline{\beta}_2(b)$ such that $\Psi[r^*(\emptyset), r^*(G), \underline{\beta}_2, b] = 0$ so that $h^*_\emptyset = 1$ for $\beta > \underline{\beta}_2(b)$ since $\Psi[r^*(\emptyset), r^*(G), \beta, b] > 0$ for $\beta \in (0, \underline{\beta}_2(b))$ and $\Psi[r^*(\emptyset), r^*(G), \beta, b] < 0$ for $\beta \in (\underline{\beta}_2(b), 1]$; when $b \in [b''_2, +\infty)$, $h^*_\emptyset$ can never be equal to 1.

The existence of PBE2 requires $0 < \underline{\beta}_2(b) < \overline{\beta}_2(b) < 1$. We firstly check the monotonicity of $\overline{\beta}_2(b)$ and $\underline{\beta}_2(b)$ w.r.t. p using Implicit Function Theorem, i.e.,

$$\frac{\partial\overline{\beta}_2}{\partial p} = -\frac{\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial p}}{\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial\beta}}.$$

where $\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial p} = [-\frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}][\theta_B V - \beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]f[\beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V] - \frac{b(1-q)(\theta_G-\theta_B)}{(1-q+qp)^2}$ and $\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial\beta} = (\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V[\theta_B V - \beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]f[\beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V] - \theta_B^2 V^2(1-\beta)f(\beta\theta_B V)$.

For $\beta \in [\theta_B/(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B), 1]$, we observe that $\overline{\beta}_2$ is increasing in p for limited b, i.e.,

$$b < \frac{[-\frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}][\theta_B V - \beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]f[\beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V](1-q+qp)^2}{(1-q)(\theta_G - \theta_B)} \equiv \bar{b}.$$

Similarly, we have

$$\frac{\partial \underline{\beta}_2}{\partial p} = -\frac{\frac{\partial \Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial p}}{\frac{\partial \Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial \beta}}$$

where $\frac{\partial \Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial p} = \frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}[\theta_\emptyset V - \beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]f[\beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V] - \int_{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\beta\theta_G V}(\theta_G - \theta_B)Vf(c)dc + \frac{b(1-q)(\theta_G-\theta_B)}{(1-q+qp)^2}$ and $\frac{\partial \Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial \beta} = \theta_G V(\theta_\emptyset V - \beta\theta_G V)f(\beta\theta_G V) - (\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V[\theta_\emptyset V - \beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]f[\beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]$.

For $\beta \in [\theta_\emptyset/\theta_G, 1]$, we observe that $\underline{\beta}_2$ is decreasing in p for limited b, i.e., $b < \bar{\bar{b}}$, where $\bar{\bar{b}} = \{\int_{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\beta\theta_G V}(\theta_G - \theta_B)Vf(c)dc - \frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}[\theta_\emptyset V - \beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]f[\beta(\frac{1-q}{1-q+qp}\theta_\emptyset + \frac{qp}{1-q+qp}\theta_B)V]\}(1-q+qp)^2/[(1-q)(\theta_G - \theta_B)]$.

Furthermore, we can observe that $\chi[r^*(\emptyset), \beta, b]$ and $\Psi[r^*(\emptyset), r^*(G), \beta, b]$ converge to

$$\int_{\beta\theta_B V}^{\beta\theta_G V}(\theta_B V - c)dF(c) + b(\theta_G - \theta_B)$$

when p converges to 0 and 1 respectively, thus $\overline{\beta}_2(b) = \underline{\beta}_2(b) < 0$ in this case. Thus, when $b < \min\{\bar{b}, \bar{\bar{b}}\}$, there must exist a threshold $\overline{p}$ s.t. when $p > \overline{p}$, we have $\underline{\beta}_2(b) < \overline{\beta}_2(b)$. Thus PBE2 ($h_B^* = 0$, $h_\emptyset^* = 1$) exists if $\underline{\beta}_2(b) < \beta < \overline{\beta}_2(b)$.

(iii) Positive Delusion ($h_B^* = 1$, $h_\emptyset^* = 0$): We have $r^*(G) = (q - qp)/(1 - qp)$ with $r^*(\emptyset)$ arbitrary since it is an off-the-equilibrium-path belief. When $s = B$,

$$\chi[r^*(\emptyset), \beta, b] = \int_{\beta\theta_B V}^{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}(\theta_B V - c)dF(c) + b[r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B - \theta_B].$$

Let

$$b_3' \equiv \frac{\int_{\theta_B V}^{[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}(c - \theta_B V)dF(c)}{r^*(\emptyset)\theta_\emptyset + [1 - r^*(\emptyset)]\theta_B - \theta_B}.$$

Notice that $\chi[r^*(\emptyset), \beta, b] = 0$ and $h_B^* = 1$ when $r^*(\emptyset) = 0$. If $r^*(\emptyset) > 0$ and $b < b_3'$, we can show similarly that there exists a $\underline{\beta}_3(b)$ such that $\chi[r^*(\emptyset), \underline{\beta}_3, b] = 0$ with $\chi[r^*(\emptyset), \beta, b]$ positive or negative depending on whether β is less than or greater than $\underline{\beta}_3(b)$. Thus $h_B^* = 1$, if $\beta > \underline{\beta}_3(b)$.

Similarly, when $s=\emptyset$,

$$\Psi[r^*(\emptyset),r^*(G),\beta,b]=\int_{\beta[r^*(\emptyset)\theta_\emptyset+(1-r^*(\emptyset))\theta_B]V}^{\beta(\frac{q-qp}{1-qp}\theta_G+\frac{1-q}{1-qp}\theta_\emptyset)V}(\theta_\emptyset V-c)dF(c)$$
$$+b\{(\frac{q-qp}{1-qp}\theta_G+\frac{1-q}{1-qp}\theta_\emptyset)-[r^*(\emptyset)\theta_\emptyset+(1-r^*(\emptyset))\theta_B]\}.$$

Let

$$b_3''\equiv\frac{\int_{\beta[r^*(\emptyset)\theta_\emptyset+(1-r^*(\emptyset))\theta_B]V}^{\beta(\frac{q-qp}{1-qp}\theta_G+\frac{1-q}{1-qp}\theta_\emptyset)V}(c-\theta_\emptyset V)dF(c)}{(\frac{q-qp}{1-qp}\theta_G+\frac{1-q}{1-qp}\theta_\emptyset)-[r^*(\emptyset)\theta_\emptyset+(1-r^*(\emptyset))\theta_B]}.$$

We can show that when $b\in[0,b_3'')$, there is a $\overline{\beta}_3(b)$ solving $\Psi[r^*(\emptyset),r^*(G),\overline{\beta}_3,b]=0$ such that $\Psi[r^*(\emptyset),r^*(G),\beta,b]$ is positive or negative depending on whether β is less than $\overline{\beta}_3(b)$ or greater than $\overline{\beta}_3(b)$ but less than $\theta_\emptyset/\theta^*(\emptyset)$. Thus, $h_\emptyset^*=0$ if $\beta<\overline{\beta}_3(b)$. It follows that PBE3 ($h_B^*=1$, $h_\emptyset^*=0$) exists if $\underline{\beta}_3(b)<\beta<\overline{\beta}_3(b)$. When $b\in[b_3'',+\infty)$, $\Psi[r^*(\emptyset),r^*(G),\beta,b]$ is always positive, thus PBE3 ($h_B^*=1$, $h_\emptyset^*=0$) exists if $\underline{\beta}_3(b)<\beta$.

Now we consider the intuitive criterion to refine this equilibrium. Note that this equilibrium is determined by the off-equilibrium belief $r^*(\emptyset)$. When $r^*(\emptyset)=0$, self-B is indifferent between recall and amnesia. When $r^*(\emptyset)>0$, he will choose to recall the bad signal for sufficiently large β. For type-$\emptyset$ self, regardless of the value of $r^*(\emptyset)$, delusion is always strictly better than correct recall when $\beta<\overline{\beta}_3(b)$. Thus after the equilibrium refinement under the intuitive criterion, self-1 knows that self-0 of type-$\emptyset$ will not correctly recall not having received a signal. Receiving such an empty signal precludes being type-$\emptyset$, so that the off-equilibrium-path belief $r^*(\emptyset)$ can only be zero. In this case, the individual is indifferent between correct recall and amnesia, and would not need a large β to remain self truthful. Thus, when β is small enough, this equilibrium prevails.

(iv) Positive Delusion with Amnesia ($h_B^*=0$, $h_\emptyset^*=0$): We have $r^*(\emptyset)=0$ and $r^*(G)=(q-qp)/(1-qp)$. When $s=B$,

$$\chi[r^*(\emptyset),\beta,b]=\int_{\beta\theta_BV}^{\beta\theta_BV}(\theta_BV-c)dF(c)+b(\theta_B-\theta_B)=0.$$

Thus $\chi[r^*(\emptyset),\beta,b]=0$, i.e., self-$B$ has no incentive to deviate from suppressing the bad signal for any β. When $s=\emptyset$,

$$\Psi[r^*(\emptyset),r^*(G),\beta,b]=\int_{\beta\theta_BV}^{\beta(\frac{q-qp}{1-qp}\theta_G+\frac{1-q}{1-qp}\theta_\emptyset)V}(\theta_\emptyset V-c)dF(c)+b\frac{1-p}{1-qp}(\theta_G-\theta_B).$$

Let

$$b_4'\equiv\frac{\int_{\theta_BV}^{(\frac{q-qp}{1-qp}\theta_G+\frac{1-q}{1-qp}\theta_\emptyset)V}(c-\theta_\emptyset V)dF(c)}{\frac{1-p}{1-qp}(\theta_G-\theta_B)}.$$

If we have

$$\int_{\theta_B V}^{(\frac{q-qp}{1-qp}\theta_G+\frac{1-q}{1-qp}\theta_\emptyset)V}(\theta_\emptyset V-c)dF(c)<0,$$

i.e., p is close to 1, we can show that when $b \in [0, b_4')$, there exists $\beta_4(b) = \overline{\beta}_3(b)$ such that $\Psi[r^*(\emptyset), r^*(G), \beta_4, b] = 0$ and that $\Psi[r^*(\emptyset), r^*(G), \beta, b]$ is positive for $\beta \in (0, \beta_4(b))$ and is negative for $\beta \in (\beta_4(b), 1]$, therefore $h^*_\emptyset = 0$ if $\beta < \beta_4(b)$; when $b \in (b_4', +\infty)$, $\Psi[r^*(\emptyset), r^*(G), \beta_4, b]$ is always positive for any β, thus $h^*_\emptyset$ equals 1. It follows that when b is small enough, PBE4 ($h^*_B = 0$, $h^*_\emptyset = 0$) exists if $\beta < \beta_4(b)$; when b is large enough, PBE4 always exists. Q.E.D.

A.2 Proof of Observation 1

For Correct Recall PBE ($h^*_B = 1$, $h^*_\emptyset = 1$), when $s = B$, we have

$$\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial\beta}=\theta^*(\emptyset)V^2[\theta_B-\beta\theta^*(\emptyset)]f[\beta\theta^*(\emptyset)V]-\theta_B V^2[\theta_B-\beta\theta_B]f(\beta\theta_B V)<0,$$

and

$$\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial b}=\theta_\emptyset-\theta_B>0.$$

According to the Implicit Function Theorem, we can simply get β' is increasing in b. Similarly, when $s = \emptyset$, β'' is increasing in b, thus we have $\max\{\beta', \beta''\}$ is increasing in b.

For Positive Amnesia PBE ($h^*_B = 0$, $h^*_\emptyset = 1$), when $s = B$, we have

$$\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial\beta}=\theta^*(\emptyset)V^2[\theta_B-\beta\theta^*(\emptyset)]f[\beta\theta^*(\emptyset)V]-\theta_B V^2[\theta_B-\beta\theta_B]f(\beta\theta_B V)<0,$$

and

$$\frac{\partial\chi[r^*(\emptyset),\beta,b]}{\partial b}=\frac{1-q}{qp+1-q}(\theta_\emptyset-\theta_B)>0.$$

Thus $\overline{\beta}_2(b)$ is increasing in b. When $s = \emptyset$, we have

$$\frac{\partial\Psi[r^*(\emptyset),r^*(G),\beta,b]}{\partial\beta}=\theta_G V^2[\theta^*(\emptyset)-\beta\theta_G]f[\beta\theta_G V]-\theta^*(\emptyset)V^2[\theta^*(\emptyset)-\beta\theta^*(\emptyset)]f[\beta\theta^*(\emptyset)V]<0,$$

and

$$\frac{\partial \Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial b} = \frac{p}{qp+1-q}(\theta_G - \theta_B) > 0.$$

Thus $\underline{\beta}_2(b)$ is increasing in b.

For Positive Delusion PBE ($h_B^* = 1$, $h_\emptyset^* = 0$), when $s = B$, we have

$$\frac{\partial \chi[r^*(\emptyset), \beta, b]}{\partial \beta} = \theta^*(\emptyset)V^2[\theta_B - \beta\theta^*(\emptyset)]f[\beta\theta^*(\emptyset)V] - \theta_B V^2[\theta_B - \beta\theta_B]f(\beta\theta_B V) < 0,$$

and

$$\frac{\partial \chi[r^*(\emptyset), \beta, b]}{\partial b} = r^*(\emptyset)\theta_\emptyset + [1 - r^*(\emptyset)]\theta_B - \theta_B > 0.$$

Thus $\underline{\beta}_3(b)$ is increasing in b. When $s = \emptyset$, we have

$$\frac{\partial \Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial \beta} = \theta^*(G)V^2[\theta^*(\emptyset) - \beta\theta^*(G)]f[\beta\theta^*(G)V] - \theta^*(\emptyset)V^2[\theta^*(\emptyset) - \beta\theta^*(\emptyset)]f[\beta\theta^*(\emptyset)V] < 0,$$

and

$$\frac{\partial \Psi[r^*(\emptyset), r^*(G), \beta, b]}{\partial b} = (\frac{q - qp}{1 - qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset) - [r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B] > 0.$$

Thus $\overline{\beta}_3(b)$ is increasing in b.

For Positive Delusion with Amnesia PBE ($h_B^* = 0$, $h_\emptyset^* = 0$), $\beta_4(b) = \overline{\beta}_3(b)$ which is inceasing in b.

All the thresholds are increasing in b. Q.E.D.

A.3 Proposition of existence of PBEs incorporating cost of memory manipulation and proof

When the cost of memory manipulation is high, i.e., $\overline{M_a} > b[\theta^*(\emptyset) - \theta_B]$ and $\overline{M_d} > b[\theta^*(G) - \theta^*(\emptyset)]$, we can get the following proposition.

Proposition 3 *(i) (PBE1: Correct Recall) For $\overline{M_a} \in (b(\theta_\emptyset - \theta_B), M_{a1})$ and $\overline{M_d} \in (b(\theta_G - \theta_\emptyset), M_{d1})$, a correct recall PBE1 ($h_B^* = 1$, $h_\emptyset^* = 1$) exists for $\beta \in [0, \min\{\beta_{11}^*, \beta_{12}^*\}) \cup (\max\{\beta_{11}^{**}, \beta_{12}^{**}\}, 1]$. For $\overline{M_a} \in (M_{a1}, +\infty)$ and $\overline{M_d} \in (b(\theta_G - \theta_\emptyset), M_{d1})$, PBE1 exists for $\beta \in [0, \beta_{12}^*) \cup (\beta_{12}^{**}, 1]$. For $\overline{M_a} \in (b(\theta_\emptyset - \theta_B), M_{a1})$ and $\overline{M_d} \in (M_{d1}, +\infty)$, PBE1 exists for $\beta \in [0, \beta_{11}^*) \cup (\beta_{11}^{**}, 1]$. For $\overline{M_a} \in (M_{a1}, +\infty)$ and $\overline{M_d} \in (M_{d1}, +\infty)$, PBE1 exists for all β.*

(ii) (PBE2: Positive Amnesia) For $\overline{M_a} \in (b[(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B) - \theta_B], M_{a2}$ *and* $\overline{M_d}$ *is smaller than and close to* M_{d2}*, PBE2 exists for* $\beta \in (\beta_{21}^*, \beta_{22}^*) \cup (\beta_{22}^{**}, \beta_{21}^{**})$*. For* $\overline{M_a} \in (b[(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B) - \theta_B], M_{a2})$ *and* $\overline{M_d} \in (M_{d2}, +\infty)$*, PBE2 exists for* $\beta \in (\beta_{21}^*, \beta_{21}^{**})$*.*

(iii) (PBE3: Positive Delusion) Given an arbitary off-equilibrium $r^*(\emptyset)$*, for* $\overline{M_a}$ *is smaller than and close to* M_{a3} *and* $\overline{M_d} \in (b[(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset) - (r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B)], M_{d3})$*, PBE3 exists for* $\beta \in (\beta_{32}^*, \beta_{31}^*) \cup (\beta_{31}^{**}, \beta_{32}^{**})$*. For* $\overline{M_a} \in (M_{a3}, +\infty)$ *and* $\overline{M_d} \in (b[(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset) - (r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B)], M_{d3})$*, PBE3 exists for* $\beta \in (\beta_{32}^*, \beta_{32}^{**})$*.*

(iv) There is no PBE with positive delusion and amnesia.

Proof: (i) PBE1 ($h_B^* = 1$, $h_\emptyset^* = 1$): We have $r^*(\emptyset) = 1$ and $r^*(G) = 1$. When $s = B$, define:

$$\chi[r^*(\emptyset), \beta, b] = \frac{1}{\overline{c}} \int_{\beta\theta_B V}^{\beta\theta^*(\emptyset)V} (\theta_B V - c)dc + b[\theta^*(\emptyset) - \theta_B] - \overline{M_a} \tag{7}$$

$$= \frac{1}{\overline{c}} \int_{\beta\theta_B V}^{\beta\theta_\emptyset V} (\theta_B V - c)dc + b(\theta_\emptyset - \theta_B) - \overline{M_a}$$

$$= A_{11}\beta^2 + B_{11}\beta + C_{11} \tag{8}$$

where

$$A_{11} \equiv -\frac{1}{2\overline{c}}(1-p)(\theta_G - \theta_B)(\theta_\emptyset + \theta_B)V^2 < 0$$

$$B_{11} \equiv \frac{1}{\overline{c}}(1-p)(\theta_G - \theta_B)\theta_B V^2 > 0$$

$$C_{11} \equiv b(1-p)(\theta_G - \theta_B) - \overline{M_a} < 0.$$

Given that $\chi[r^*(\emptyset), \beta, b]$ is a quadratic function of β, the solution for $\chi[r^*(\emptyset), \beta, b] = 0$ exists if and only if

$$D_{11}^2 - 4A_{11}C_{11} \geq 0 \Leftrightarrow \overline{M_a} \leq \frac{1}{2}(1-p)(\theta_G - \theta_B)[2b + \frac{\theta_B^2 V^2}{\overline{c}(\theta_\emptyset + \theta_B)}].$$

When the condition above is satisfied, two solutions for $\chi[r^*(\emptyset), \beta, b] = 0$ are:

$$\beta_{11}^* = \frac{(1-p)(\theta_G - \theta_B)\theta_B V^2 - \sqrt{D_{11}}}{(1-p)(\theta_G - \theta_B)(\theta_\emptyset + \theta_B)V^2}$$

$$\beta_{11}^{**} = \frac{(1-p)(\theta_G - \theta_B)\theta_B V^2 + \sqrt{D_{11}}}{(1-p)(\theta_G - \theta_B)(\theta_\emptyset + \theta_B)V^2}$$

where $D_{11} = (1-p)(\theta_G - \theta_B)V^2\{2\overline{c}[b(1-p)(\theta_G - \theta_B) - \overline{M_a}](\theta_\emptyset + \theta_B) + (1-p)(\theta_G - \theta_B)\theta_B^2 V^2\}$.

It follows that $\chi[r^*(\emptyset), \beta, b]$ is positive for $\beta \in (\beta_{11}^*, \beta_{11}^{**})$ and negative for $\beta \in [0, \beta_{11}^*) \cup (\beta_{11}^{**}, 1]$. Therefore, $h_B^* = 1$ if $\beta \in [0, \beta_{11}^*) \cup (\beta_{11}^{**}, 1]$.

For

$$\overline{M_a} > \frac{1}{2}(1-p)(\theta_G - \theta_B)[2b + \frac{\theta_B^2 V^2}{\overline{c}(\theta_\emptyset + \theta_B)}] \equiv M_{a1},$$

there is no solution for $\chi[r^*(\emptyset), \beta, b] = 0$, $h_B^* = 1$ for any β.

When $s = \emptyset$, we can similarly define:

$$\Psi[r^*(\emptyset), r^*(G), \beta, b] = \frac{1}{\overline{c}} \int_{\beta\theta^*(\emptyset)V}^{\beta\theta^*(G)V} (\theta_\emptyset V - c)dc + b[\theta^*(G) - \theta^*(\emptyset)] - \overline{M_d} \tag{9}$$

$$= \frac{1}{\overline{c}} \int_{\beta\theta_\emptyset V}^{\beta\theta_G V} (\theta_\emptyset V - c)dc + b(\theta_G - \theta_\emptyset) - \overline{M_d}$$

$$= A_{12}\beta^2 + B_{12}\beta + C_{12} \tag{10}$$

where

$$A_{12} \equiv -\frac{1}{2\overline{c}} p(\theta_G - \theta_B)(\theta_G + \theta_\emptyset)V^2 < 0$$

$$B_{12} \equiv \frac{1}{\overline{c}} p(\theta_G - \theta_B)\theta_\emptyset V^2 > 0$$

$$C_{12} \equiv bp(\theta_G - \theta_B) - \overline{M_d} < 0.$$

Given that $\Psi[r^*(\emptyset), r^*(G), \beta, b]$ is a quadratic function of β, the solution for $\Psi[r^*(\emptyset), r^*(G), \beta, b] = 0$ exists if and only if

$$B_{12}^2 - 4A_{12}C_{12} \geq 0 \Leftrightarrow \overline{M_d} \leq \frac{1}{2}p(\theta_G - \theta_B)[2b + \frac{\theta_\emptyset^2 V^2}{\overline{c}(\theta_\emptyset + \theta_G)}].$$

When the condition above is satisfied, two solutions for $\Psi[r^*(\emptyset), r^*(G), \beta, b] = 0$ are:

$$\beta_{12}^* = \frac{p(\theta_G - \theta_B)\theta_\emptyset V^2 - \sqrt{p(\theta_G - \theta_B)V^2\{2\overline{c}[bp(\theta_G - \theta_B) - \overline{M_d}](\theta_\emptyset + \theta_G) + p(\theta_G - \theta_B)\theta_\emptyset^2 V^2\}}}{p(\theta_G - \theta_B)(\theta_\emptyset + \theta_G)V^2}$$

$$\beta_{12}^{**} = \frac{p(\theta_G - \theta_B)\theta_\emptyset V^2 + \sqrt{p(\theta_G - \theta_B)V^2\{2\overline{c}[bp(\theta_G - \theta_B) - \overline{M_d}](\theta_\emptyset + \theta_G) + p(\theta_G - \theta_B)\theta_\emptyset^2 V^2\}}}{p(\theta_G - \theta_B)(\theta_\emptyset + \theta_G)V^2}$$

It follows that $\Psi[r^*(\emptyset), r^*(G), \beta, b]$ is positive for $\beta \in (\beta_{12}^*, \beta_{12}^{**})$ and negative for $\beta \in [0, \beta_{12}^*) \cup (\beta_{12}^{**}, 1]$. Therefore, $h_\emptyset^* = 1$ if $\beta \in [0, \beta_{12}^*) \cup (\beta_{12}^{**}, 1]$.

For

$$\overline{M_d} > \frac{1}{2}p(\theta_G - \theta_B)[2b + \frac{\theta_\emptyset^2 V^2}{\overline{c}(\theta_\emptyset + \theta_G)}] \equiv M_{d1},$$

there is no solution for $\Psi[r^*(\emptyset), r^*(G), \beta, b] = 0$, $h^*_\emptyset = 1$ for any β.

In summary, for $\overline{M_a} \in (b(\theta_\emptyset - \theta_B), M_{a1})$ and $\overline{M_d} \in (b(\theta_G - \theta_\emptyset), M_{d1})$, a correct recall PBE1 ($h^*_B = 1$, $h^*_\emptyset = 1$) exists for $\beta \in [0, \min\{\beta^*_{11}, \beta^*_{12}\}) \cup (\max\{\beta^{**}_{11}, \beta^{**}_{12}\}, 1]$. For $\overline{M_a} \in (M_{a1}, +\infty)$ and $\overline{M_d} \in (b(\theta_G - \theta_\emptyset), M_{d1})$, PBE1 exists for $\beta \in [0, \beta^*_{12}) \cup (\beta^{**}_{12}, 1]$. For $\overline{M_a} \in (b(\theta_\emptyset - \theta_B), M_{a1})$ and $\overline{M_d} \in (M_{d1}, +\infty)$, PBE1 exists for $\beta \in [0, \beta^*_{11}) \cup (\beta^{**}_{11}, 1]$. For $\overline{M_a} \in (M_{a1}, +\infty)$ and $\overline{M_d} \in (M_{d1}, +\infty)$, PBE1 exists for all β.

(ii) PBE2 ($h^*_B = 0$, $h^*_\emptyset = 1$): We have $r^*(\emptyset) = (1-q)/(qp+1-q)$ and $r^*(G) = 1$. When $s = B$,

$$\chi[r^*(\emptyset), \beta, b] = \frac{1}{\overline{c}} \int_{\beta\theta_B V}^{\beta\theta^*(\emptyset)V} (\theta_B V - c)dc + b[\theta^*(\emptyset) - \theta_B] - \overline{M_a} \tag{11}$$

$$= \frac{1}{\overline{c}} \int_{\beta\theta_B V}^{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V} (\theta_B V - c)dc + b\frac{1-q}{qp+1-q}(\theta_\emptyset - \theta_B) - \overline{M_a}$$

$$= A_{21}\beta^2 + B_{21}\beta + C_{21} \tag{12}$$

where

$$A_{21} \equiv -\frac{(1-p)(1-q)(\theta_G - \theta_B)[(1+p-q+qp)\theta_B + (1-p)(1-q)\theta_G]V^2}{2(1-q+qp)^2\overline{c}} < 0$$

$$B_{21} \equiv \frac{(1-p)(1-q)(\theta_G - \theta_B)\theta_B V^2}{(1-q+qp)\overline{c}} > 0$$

$$C_{21} \equiv \frac{[b(1-p)(1-q)(\theta_G - \theta_B) - (1-q+qp)\overline{M_a}]}{1-q+qp} < 0.$$

Given that $\chi[r^*(\emptyset), \beta, b]$ is a quadratic function of β, the solution for $\chi[r^*(\emptyset), \beta, b] = 0$ exists if and only if

$$D^2_{21} - 4A_{21}C_{21} \geq 0 \Leftrightarrow \overline{M_a} \leq \frac{1}{2}(1-p)(1-q)(\theta_G - \theta_B)\{\frac{2b}{1-q+qp} + \frac{\theta^2_B V^2}{\overline{c}[(1+p-q+qp)\theta_B + (1-p)(1-q)\theta_G]}\}.$$

When the condition above is satisfied, two solutions for $\chi[r^*(\emptyset), \beta, b] = 0$ are β^*_{21} and $\beta^{**}_{21} \in (0,1)$ where $\beta^*_{21} \leq \beta^{**}_{21}$. Specifically,

$$\beta^*_{21} = \frac{(1-p)(1-q)(1-q+qp)(\theta_G - \theta_B)\theta_B V^2 - \sqrt{D_{21}}}{(1-p)(1-q)(1-q+qp)(\theta_G - \theta_B)[(1-p)(1-q)\theta_G + (1+p-q+qp)\theta_B]V^2}$$

$$\beta^{**}_{21} = \frac{(1-p)(1-q)(1-q+qp)(\theta_G - \theta_B)\theta_B V^2 + \sqrt{D_{21}}}{(1-p)(1-q)(1-q+qp)(\theta_G - \theta_B)[(1-p)(1-q)\theta_G + (1+p-q+qp)\theta_B]V^2}.$$

where $D_{21} = (1-p)(1-q)(1-q+qp)(\theta_G - \theta_B)V^2\{2\overline{c}[b(1-p)(1-q)(\theta_G - \theta_B) - (1-q+qp)\overline{M}_a][(1-p)(1-q)\theta_G + (1+p-q+qp)\theta_B] + (1-p)(1-q)(1-q+qp)\theta^2_B(\theta_G - \theta_B)V^2\}$.

Thus $\chi[r^*(\emptyset),\beta,b] > 0$ for $\beta \in (\beta_{21}^*,\beta_{21}^{**})$ and $\chi[r^*(\emptyset),\beta,b] < 0$ for $\beta \in [0,\beta_{21}^*) \cup (\beta_{21}^{**},1]$. It follows that $h_B^* = 0$ if $\beta \in (\beta_{21}^*,\beta_{21}^{**})$. For

$$\overline{M_a} > \frac{1}{2}(1-p)(1-q)(\theta_G-\theta_B)\{\frac{2b}{1-q+qp} + \frac{\theta_B^2 V^2}{\overline{c}[(1+p-q+qp)\theta_B + (1-p)(1-q)\theta_G]}\} \equiv M_{a2},$$

$\chi[r^*(\emptyset),\beta,b]$ is always negative, which means that h_B^* can never reach 0 for any β. When $s=\emptyset$,

$$\Psi[r^*(\emptyset),r^*(G),\beta,b] = \frac{1}{\overline{c}}\int_{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset+\frac{qp}{qp+1-q}\theta_B)V}^{\beta\theta_G V}(\theta_\emptyset V-c)dc + b\frac{p}{qp+1-q}(\theta_G-\theta_B) - \overline{M_d}$$
$$= A_{22}\beta^2 + B_{22}\beta + C_{22}$$

where

$$A_{22} \equiv -\frac{p(\theta_G-\theta_B)[\theta_\emptyset + (1-2q+2qp)\theta_G]V^2}{2(1-q+qp)^2\overline{c}} < 0$$
$$B_{22} \equiv \frac{p(\theta_G-\theta_B)(\theta_\emptyset+\theta_G)V^2}{(1-q+qp)\overline{c}} > 0$$
$$C_{22} \equiv \frac{bp(\theta_G-\theta_B)}{1-q+qp} - \overline{M_d} < 0.$$

Given that $\Psi[r^*(\emptyset),r^*(G),\beta,b]$ is a quadratic function of β, the solution for $\Psi[r^*(\emptyset),r^*(G),\beta,b] = 0$ exists if and only if

$$B_{22}^2 - 4A_{22}C_{22} \geq 0 \Leftrightarrow \overline{M_d} \leq \frac{1}{2}p(\theta_G-\theta_B)\{\frac{2b}{1-q+qp} + \frac{\theta_\emptyset^2 V^2}{\overline{c}[\theta_\emptyset + (1-2q+2qp)\theta_G]}\} \equiv M_{d2}.$$

When the condition above is satisfied, with large enough p, two solutions for $\Psi[r^*(\emptyset),r^*(G),\beta,b] = 0$ are β_{22}^* and $\beta_{22}^{**} \in (0,1)$ where $\beta_{22}^* \leq \beta_{22}^{**}$. Thus $\Psi[r^*(\emptyset),r^*(G),\beta,b] > 0$ for $\beta \in (\beta_{22}^*,\beta_{22}^{**})$ and $\chi[r^*(\emptyset),\beta,b] < 0$ for $\beta \in [0,\beta_{22}^*) \cup (\beta_{22}^{**},1]$. It follows that $h_\emptyset^* = 1$ if $\beta \in [0,\beta_{22}^*) \cup (\beta_{22}^{**},1]$. Simple algebra shows that $\frac{\partial\beta_{21}^*}{\partial\overline{M_a}} > 0$, $\frac{\partial\beta_{21}^{**}}{\partial\overline{M_a}} < 0$, $\frac{\partial\beta_{22}^*}{\partial\overline{M_d}} > 0$, $\frac{\partial\beta_{22}^{**}}{\partial\overline{M_d}} < 0$. Moreover, when $\overline{M_d} = \frac{1}{2}p(\theta_G-\theta_B)\{\frac{2b}{1-q+qp} + \frac{\theta_\emptyset^2 V^2}{\overline{c}[\theta_\emptyset+(1-2q+2qp)\theta_G]}\} \equiv M_{d2}$, $\beta_{22}^* = \beta_{22}^{**} = \frac{(1-q+qp)(\theta_\emptyset+\theta_G)}{\theta_\emptyset+(1-2q+2qp)\theta_G}$, which is higher than 0 and lower than β_{21}^{**} for some limited $\overline{M_a}$. It is straightforward that when $\overline{M_d}$ is close to M_{d2}, PBE2 exists for $\beta \in (\beta_{21}^*,\beta_{22}^*) \cup (\beta_{22}^{**},\beta_{21}^{**})$.

(iii) PBE3 ($h_B^* = 1$, $h_\emptyset^* = 0$): We have $r^*(G) = (q-qp)/(1-qp)$ with $r^*(\emptyset)$ arbitrary. When $s = B$,

$$\chi[r^*(\emptyset),\beta,b] = \frac{1}{\overline{c}}\int_{\beta\theta_B V}^{\beta[r^*(\emptyset)\theta_\emptyset+(1-r^*(\emptyset))\theta_B]V}(\theta_B V-c)dc + b[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B - \theta_B] - \overline{M_a}$$
$$= A_{31}\beta^2 + B_{31}\beta + C_{31}$$

where

$$A_{31} \equiv -\frac{1}{2\overline{c}}(1-p)r^*(\emptyset)(\theta_G-\theta_B)\{(1-p)r^*(\emptyset)\theta_G + [2-(1-p)r^*(\emptyset)]\theta_B\}V^2 < 0$$

$$B_{31} \equiv \frac{1}{\bar{c}}(1-p)r^*(\emptyset)(\theta_G - \theta_B)\theta_B V^2 > 0$$
$$C_{31} \equiv b(1-p)r^*(\emptyset)(\theta_G - \theta_B) - \overline{M_a} < 0.$$

When the off-equilibrium belief $r^*(\emptyset) = 0$, $\chi[r^*(\emptyset), \beta, b]$ is always negative, a type-B always chooses to remember the bad signal for any β, thus $r^*(\emptyset)$ is arbitrary and positive. The solution for $\chi[r^*(\emptyset), \beta, b] = 0$ exists if and only if

$$B_{31}^2 - 4A_{31}C_{31} \geq 0 \Leftrightarrow \overline{M_a} \leq \frac{1}{2}(1-p)r^*(\emptyset)(\theta_G - \theta_B)\{2b + \frac{\theta_B^2 V^2}{\bar{c}[(2-(1-p)r^*(\emptyset))\theta_B + (1-p)r^*(\emptyset)\theta_G]}\} \equiv M_{a3}.$$

When the condition above is satisfied, two solutions for $\chi[r^*(\emptyset), \beta, b] = 0$ are β_{31}^* and $\beta_{31}^{**} \in (0,1)$ where $\beta_{31}^* \leq \beta_{31}^{**}$. It follows that $\chi[r^*(\emptyset), \beta, b]$ is positive for $\beta \in (\beta_{31}^*, \beta_{31}^{**})$ and negative for $\beta \in [0, \beta_{31}^*) \cup (\beta_{31}^{**}, 1]$. Therefore, $h_B^* = 1$ if $\beta \in [0, \beta_{31}^*) \cup (\beta_{31}^{**}, 1]$.

For $\overline{M_a} > M_{a3}$, $h_B^* = 1$ for any β.

When $s = \emptyset$,

$$\begin{aligned}
\Psi[r^*(\emptyset), r^*(G), \beta, b] &= \frac{1}{\bar{c}} \int_{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}^{\beta(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset)V} (\theta_\emptyset V - c)dc \\
&+ b\{(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset) - [r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]\} - \overline{M_d} \\
&= A_{32}\beta^2 + B_{32}\beta + C_{32}
\end{aligned}$$

where

$$A_{32} \equiv -\frac{1}{2\bar{c}(1-qp)^2}(1-p)[1-(1-qp)r^*(\emptyset)](\theta_G - \theta_B)$$
$$\{(1-p)[1+(1+qp)r^*(\emptyset)]\theta_G + [1+p-2qp-(1-p)(1-qp)r^*(\emptyset)]\theta_B\}V^2 < 0$$
$$B_{32} \equiv \frac{(1-p)[1-(1-qp)r^*(\emptyset)](\theta_G - \theta_B)[\theta_G - p(\theta_G - \theta_B)]V^2}{\bar{c}(1-qp)} > 0$$
$$C_{32} \equiv \frac{b(1-p)[1-(1-qp)r^*(\emptyset)](\theta_G - \theta_B)}{1-qp} - \overline{M_d} < 0.$$

The solution for $\Psi[r^*(\emptyset), r^*(G), \beta, b] = 0$ exists if and only if

$$\begin{aligned}
B_{32}^2 - 4A_{32}C_{32} \geq 0 \Leftrightarrow \overline{M_d} &\leq \frac{1}{2}(1-p)[1-(1-qp)r^*(\emptyset)](\theta_G - \theta_B) \\
&\{\frac{2b}{1-qp} + \frac{[\theta_G - p(\theta_G - \theta_B)]^2 V^2}{\bar{c}\{(1-p)[1+(1+qp)r^*(\emptyset)]\theta_G + [1+p-2qp-(1-p)(1-qp)r^*(\emptyset)]\theta_B\}}\} \equiv M_{d3}.
\end{aligned}$$

When the condition above is satisfied, two solutions for $\Psi[r^*(\emptyset), r^*(G), \beta, b] = 0$ are β_{32}^* and $\beta_{32}^{**} \in (0,1)$ where $\beta_{32}^* \leq \beta_{32}^{**}$. It follows that $\Psi[r^*(\emptyset), r^*(G), \beta, b]$ is positive for $\beta \in (\beta_{32}^*, \beta_{32}^{**})$ and negative for $\beta \in [0, \beta_{32}^*) \cup (\beta_{32}^{**}, 1]$. Therefore, $h_\emptyset^* = 1$ if $\beta \in [0, \beta_{32}^*) \cup (\beta_{32}^{**}, 1]$.

For $\overline{M_d} > M_{d3}$, $h^*_\emptyset$ is always equal to 1.

(iv) The case for $h^*_B = 0$ and $h^*_\emptyset = 0$: We have $r^*(\emptyset) = 0$ and $r^*(G) = (q - qp)/(1 - qp)$. When $s = B$,

$$\chi[r^*(\emptyset), \beta, b] = \int_{\beta\theta_B V}^{\beta\theta_B V} (\theta_B V - c)dF(c) + b(\theta_B - \theta_B) - \overline{M_a} < 0.$$

Thus a type-B does not choose to forget bad signal. There is no PBE in this case. Q.E.D.

A.4 One-Step Extended Model with Confabulation

Keeping the setup of the baseline model, we include the additional possibility of transforming the bad signal ($s = B$) into a good signal ($\hat{s} = G$) in addition to recalling the bad signal correctly ($\hat{s} = B$) or forgetting the bad signal ($\hat{s} = \emptyset$). The corresponding memory management strategy (see Figure 4) is then given by the probability of truthful transmission h_{BB}, probability of suppressing the bad signal $h_{B\emptyset}$ (amnesia), and probability of transforming the bad signal into a good signal $1 - h_{BB} - h_{B\emptyset}$ (confabulation).

Equilibria	h_{BB}	$h_{B\emptyset}$	$h_\emptyset$	Present Bias β	Positive Amnesia	Positive Delusion	Positive Confabulation
PBE1	1	0	1	Large enough	N	N	N
PBE2	0	1	1	Intermediate	Y	N	N
PBE3	1	0	0		N	Y	N
PBE4	0	1	0		Y	Y	N
PBE5	0	0	0	Small enough	N	Y	Y
PBE6	0	0	1		N	N	Y

Table 3: Equilibria for the One-Step Motivated False Memory Model

For the present case incorporating the possibility of positive confabulation, we can apply the preceding analysis and identify six possible PBEs (shown in Table 3) including four PBEs inherited from the case of no confabulation. The two additional equilibria – PBE5 and PBE6 – each involving positive confabulation arise when present bias is sufficiently severe. In PBE5, self-0 of type-$\emptyset$ reports the empty signal truthfully, while he fabricates an empty signal into a good signal in PBE6. Yet, an individual of type-B exhibits confabulation to deliver over confidence in both equilibria. Here, the expected ability assessment of self-1 upon receiving a good signal is always $\theta^*(G) = p\theta_B + (1-p)\theta_G$, no matter what memory strategy self-0 of type-$\emptyset$ chooses, i.e., self-0 of type-$\emptyset$ is always indifferent between creating a fake good signal and otherwise. Thus, instrumental value of positive delusion is invalidated by the presence of positive confabulation leaving it alone to deliver over confidence when present bias is sufficiently severe. From Table 3, it is apparent that there is no monotonic relation between present bias and positive amnesia or positive delusion. Summarizing, we have the following proposition.

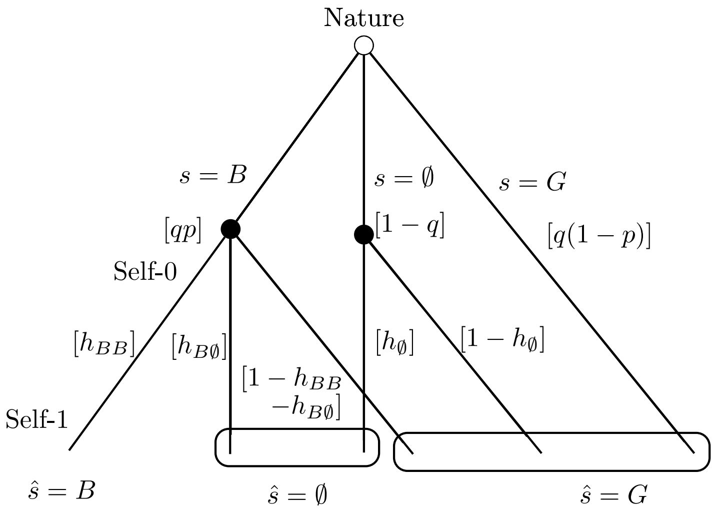


Figure 4: Memory management with one-step confabulation

Proposition 4 *In the presence of the possibility of confabulation, only the likelihood of positive confabulation increases in the degree of present bias. This is not the case for positive amnesia or positive delusion.*

We note that the implication of this proposition is not consistent with two key results of our experiment: positive delusion and positive confabulation are each related to positively present bias (Result 5). Moreover, positive confabulation tends to involve two steps – positive amnesia followed by positive delusion (Result 3). This motivates a two-step motivated false memory model.

A.5 Proof of Proposition 2

(i) Correct Recall ($\tilde{h_B^*} = 1$, $\tilde{h_\emptyset^*} = 1$): We have $\tilde{r^*}(\emptyset) = 1$ and $\tilde{r^*}(G) = 1$. When $s = B$, define:

$$\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta_B V}^{\beta\theta^*(\emptyset)V} (\theta_B V - c)dF(c) + b[\theta^*(\emptyset) - \theta_B] \tag{13}$$

$$= \int_{\beta\theta_B V}^{\beta\theta_\emptyset V} (\theta_B V - c)dF(c) + b(\theta_\emptyset - \theta_B).$$

When $\hat{s} = B$, define:

$$\chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta_B V}^{\beta\theta^*(\emptyset)V} (\theta_B V - c)dF(c) + b[\theta^*(\emptyset) - \theta_B] \tag{14}$$
$$= \int_{\beta\theta_B V}^{\beta\theta_\emptyset V} (\theta_B V - c)dF(c) + b(\theta_\emptyset - \theta_B).$$

Let

$$b_1' \equiv \frac{\int_{\theta_B V}^{\theta_\emptyset V}(c - \theta_B V)dF(c)}{\theta_\emptyset - \theta_B}.$$

Notice that when $b \in [0, b_1')$, $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), 1, b] = \chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), 1, b] < 0$ and that $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] > 0$ for $\beta \in (0, \theta_B/\theta_\emptyset]$.

It follows that there exists $\beta'(b) \in (\theta_B/\theta_\emptyset, 1)$ such that $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta', b] = \chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta', b] = 0$. Moreover, $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ and $\chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ are positive for $\beta \in (0, \beta'(b))$ and negative for $\beta \in (\beta'(b), 1)$, and

$$\frac{\partial \chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]}{\partial \beta} = \frac{\partial \chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]}{\partial \beta} = \theta^*(\emptyset)V^2[\theta_B - \beta\theta^*(\emptyset)]f[\beta\theta^*(\emptyset)V] - \theta_B V^2[\theta_B - \beta\theta_B]f(\beta\theta_B V) < 0,$$

for $\beta \in [\theta_B/\theta_\emptyset, 1]$. When the individual chooses $\tilde{h_B^*}$, he cannot tell which stage he is at, while $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ and $\chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ are always the same. Therefore, $\tilde{h_B^*} = 1$, if $\beta > \beta'(b)$. When $b \in [b_1', +\infty)$, $\chi[r^*(\emptyset), \beta, b]$ is always positive for any β, thus $\tilde{h_B^*}$ can never reach 1.

When $s = \emptyset$, we can similarly define:

$$\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta^*(\emptyset)V}^{\beta\theta^*(G)V} (\theta_\emptyset V - c)dF(c) + b[\theta^*(G) - \theta^*(\emptyset)] \tag{15}$$
$$= \int_{\beta\theta_\emptyset V}^{\beta\theta_G V} (\theta_\emptyset V - c)dF(c) + b(\theta_G - \theta_\emptyset).$$

When $\hat{s} = \emptyset$, we define:

$$\Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta^*(\emptyset)V}^{\beta\theta^*(G)V} (\theta_\emptyset V - c)dF(c) + b[\theta^*(G) - \theta^*(\emptyset)] \tag{16}$$
$$= \int_{\beta\theta_\emptyset V}^{\beta\theta_G V} (\theta_\emptyset V - c)dF(c) + b(\theta_G - \theta_\emptyset).$$

Let

$$b_1'' \equiv \frac{\int_{\theta_\emptyset V}^{\theta_G V}(c - \theta_\emptyset V)dF(c)}{\theta_G - \theta_\emptyset}.$$

When $b \in [0, b_1'')$, we have that $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), 1, b] = \Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), 1, b] < 0$ and $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] > 0$ for $\beta \in (0, \theta_\emptyset/\theta_G]$. We also have $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta'', b] = \Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta'', b] = 0$ for some $\beta''(b) \in (\theta_\emptyset/\theta_G, 1)$. Thus, $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ is positive for $\beta \in (0, \beta''(b))$ and negative for $\beta \in (\beta''(b), 1)$, and

$$\frac{\partial \Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]}{\partial \beta} = \frac{\partial \Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]}{\partial \beta} = \theta_G V^2[\theta_\emptyset - \beta\theta_G] f(\beta\theta_G V) - \theta_\emptyset V^2 [\theta_\emptyset - \beta\theta_\emptyset] f(\beta\theta_\emptyset V) < 0,$$

for $\beta \in [\theta_\emptyset/\theta_G, 1]$. Thus, $\tilde{h_\emptyset^*} = 1$, if $\beta > \beta''(b)$. When $b \in [b_1'', +\infty)$, $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ and $\Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ is always positive for any β, thus $\tilde{h_\emptyset^*}$ can never reach 1. It follows that a correct recall PBE ($h_B^* = 1$, $h_\emptyset^* = 1$) exists for $\beta > \max\{\beta'(b), \beta''(b)\}$ when $b < \min\{b_1', b_1''\}$.

(ii) Positive Amnesia ($\tilde{h_B^*} = 0$, $\tilde{h_\emptyset^*} = 1$): We have $\tilde{r^*}(\emptyset) = (1-q)/(qp+1-q)$ and $\tilde{r^*}(G) = 1$. When $s = B$,

$$\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta_B V}^{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V} (\theta_B V - c) dF(c) + b\frac{1-q}{qp+1-q}(\theta_\emptyset - \theta_B).$$

We also have $\hat{s} \neq B$ in this equilibrium.

Let

$$b_2' \equiv \frac{\int_{\theta_B V}^{(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V} (c - \theta_B V) dF(c)}{\frac{1-q}{qp+1-q}(\theta_\emptyset - \theta_B)}.$$

As with the proof of existence of the perfect recall PBE, when $b \in [0, b_2')$, there exists $\overline{\beta}_2(b)$ such that $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] > 0$ for $\beta \in (0, \overline{\beta}_2(b))$ and $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] < 0$ for $\beta \in (\overline{\beta}_2(b), 1)$. It follows that $\tilde{h_B^*} = 0$ if $\beta < \overline{\beta}_2(b)$; when $b \in [b_2', +\infty)$, $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ is always positive. When $s = \emptyset$,

$$\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\beta\theta_G V} (\theta_\emptyset V - c) dF(c) + b\frac{p}{qp+1-q}(\theta_G - \theta_B).$$

When $\hat{s} = \emptyset$,

$$\Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\beta\theta_G V} [(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V - c] dF(c)$$
$$+ b\frac{p}{qp+1-q}(\theta_G - \theta_B).$$

It is obvious that $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] > \Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ for $\beta \in (0, 1]$ and $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), 0, b] = \Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), 0, b]$.

Let

$$b_2'' \equiv \frac{\int_{(\frac{1-q}{qp+1-q}\theta_\emptyset + \frac{qp}{qp+1-q}\theta_B)V}^{\theta_G V} (c - \theta_\emptyset V) dF(c)}{\frac{p}{qp+1-q}(\theta_G - \theta_B)}$$

and

$$b_2''' \equiv \frac{\int_{(\frac{1-q}{qp+1-q}\theta_\emptyset+\frac{qp}{qp+1-q}\theta_B)V}^{\theta_G V}[c-(\frac{1-q}{qp+1-q}\theta_\emptyset+\frac{qp}{qp+1-q}\theta_B)V]dF(c)}{\frac{p}{qp+1-q}(\theta_G-\theta_B)} > b_2''.$$

If we have

$$\int_{(\frac{1-q}{qp+1-q}\theta_\emptyset+\frac{qp}{qp+1-q}\theta_B)V}^{\theta_G V}(\theta_\emptyset V-c)dF(c)<0,$$

i.e., p is close to 1, we can conclude that when $b\in[0,b_2'')$, there is a $\underline{\beta}_2(b)$ such that $\Psi[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\underline{\beta}_2(b),b]=0$, $\Psi[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]>0$ for $\beta<\underline{\beta}_2(b)$ and $\Psi[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]<0$ for $\beta>\underline{\beta}_2(b)$. Similarly, when $b\in[0,b_2''')$, there is a $\underline{\underline{\beta}}_2(b)$ such that $\Psi'[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\underline{\underline{\beta}}_2(b),b]=0$, $\Psi'[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]>0$ for $\beta<\underline{\underline{\beta}}_2(b)$ and $\Psi'[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]<0$ for $\beta>\underline{\underline{\beta}}_2(b)$. It is straightforward to show that $\underline{\beta}_2(b)>\underline{\underline{\beta}}_2(b)$. Given that when the individual receives an empty signal, he does not know which step he is at, he chooses $\tilde{h}_\emptyset^*=1$ for $\beta>\underline{\beta}_2(b)$ since $\Psi'[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]>0$ for $\beta\in(0,\underline{\beta}_2(b))$ and $\Psi'[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]<0$ for $\beta\in(\underline{\beta}_2(b),1]$; when $b\in[b_2'',+\infty)$, $\tilde{h}_\emptyset^*$ can not be equal to 1.

The existence of Positive Amnesia equilibrium requires $0<\underline{\beta}_2(b)<\overline{\beta}_2(b)<1$. Let $\widetilde{\theta}\equiv\frac{1-q}{1-q+qp}\theta_\emptyset+\frac{qp}{1-q+qp}\theta_B$. We firstly check the monotonicity of $\overline{\beta}_2(b)$ and $\underline{\beta}_2(b)$ w.r.t. p using Implicit Function Theorem, i.e.,

$$\begin{aligned}\frac{\partial\overline{\beta}_2}{\partial p}&=-\frac{\frac{\partial\chi[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]}{\partial p}}{\frac{\partial\chi[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]}{\partial\beta}}\\&=-\frac{[-\frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}][\theta_B V-\beta\widetilde{\theta}V]f[\beta\widetilde{\theta}V]-\frac{b(1-q)(\theta_G-\theta_B)}{(1-q+qp)^2}}{\widetilde{\theta}V[\theta_B V-\beta\widetilde{\theta}V]f[\beta\widetilde{\theta}V]-\theta_B^2V^2(1-\beta)f(\beta\theta_B V)}.\end{aligned}$$

For $\beta\in[\theta_B/(\frac{1-q}{1-q+qp}\theta_\emptyset+\frac{qp}{1-q+qp}\theta_B),1]$, we observe that $\overline{\beta}_2$ is increasing in p for limited b, i.e.,

$$b<\frac{[-\frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}][\theta_B V-\beta\widetilde{\theta}V]f[\beta\widetilde{\theta}V](1-q+qp)^2}{(1-q)(\theta_G-\theta_B)}\equiv\overline{b}.$$

Similarly, we have

$$\begin{aligned}\frac{\partial\underline{\beta}_2}{\partial p}&=-\frac{\frac{\partial\Psi[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]}{\partial p}}{\frac{\partial\Psi[\tilde{r^*}(\emptyset),\tilde{r^*}(G),\beta,b]}{\partial\beta}}\\&=-\frac{\frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}[\theta_\emptyset V-\beta\widetilde{\theta}V]f[\beta\widetilde{\theta}V]-\int_{\beta(\frac{1-q}{qp+1-q}\theta_\emptyset+\frac{qp}{qp+1-q}\theta_B)V}^{\beta\theta_G V}(\theta_G-\theta_B)Vf(c)dc+\frac{b(1-q)(\theta_G-\theta_B)}{(1-q+qp)^2}}{\theta_G V(\theta_\emptyset V-\beta\theta_G V)f(\beta\theta_G V)-\widetilde{\theta}V[\theta_\emptyset V-\beta\widetilde{\theta}V]f[\beta\widetilde{\theta}V]}.\end{aligned}$$

For $\beta \in [\theta_\emptyset/\theta_G, 1]$, we observe that $\underline{\beta}_2$ is decreasing in p for limited b, i.e.,

$$b < \frac{\{\int_{\beta\widetilde{\theta}V}^{\beta\theta_G V}(\theta_G - \theta_B)Vf(c)dc - \frac{\beta(1-q)(\theta_G-\theta_B)V}{(1-q+qp)^2}[\theta_\emptyset V - \beta\widetilde{\theta}V]f[\beta\widetilde{\theta}V]\}(1-q+qp)^2}{(1-q)(\theta_G - \theta_B)} \equiv \overline{\overline{b}}.$$

Furthermore, we can observe that $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ and $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ converge to

$$\int_{\beta\theta_B V}^{\beta\theta_G V}(\theta_B V - c)dF(c) + b(\theta_G - \theta_B)$$

when p converges to 0 and 1 respectively, thus $\overline{\beta}_2(b) = \underline{\beta}_2(b) < 0$ in this case. Thus, when $b < \min\{\overline{b}, \overline{\overline{b}}\}$, there must exist a threshold $\overline{p}$ s.t. when $p > \overline{p}$, we have $\underline{\beta}_2(b) < \overline{\beta}_2(b)$. Thus Positive Amnesia equilibrium ($\tilde{h^*_B} = 0$, $\tilde{h^*_\emptyset} = 1$) exists if $\underline{\beta}_2(b) < \beta < \overline{\beta}_2(b)$ when $b < \min\{\overline{b}, \overline{\overline{b}}, b_2', b_2''\}$.
(iii) Positive Delusion ($\tilde{h^*_B} = 1$, $\tilde{h^*_\emptyset} = 0$): We have $\tilde{r^*}(G) = (q - qp)/(1 - qp)$ with $\tilde{r^*}(\emptyset)$ arbitrary since it is an off-the-equilibrium-path belief. When $s = B$,

$$\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta_B V}^{\beta\theta_G V}(\theta_B V - c)dF(c) + b(\theta_G - \theta_B).$$

When $\hat{s} = B$,

$$\chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta_B V}^{\beta\{\tilde{r^*}(\emptyset)\theta_\emptyset + [1-\tilde{r^*}(\emptyset)]\theta_B\}V}(\theta_B V - c)dF(c) + b[r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B - \theta_B].$$

Let

$$b_3' \equiv \frac{\int_{\theta_B V}^{\theta_G V}(c - \theta_B V)dF(c)}{\theta_G - \theta_B}$$

and

$$b_3'' \equiv \frac{\int_{\theta_B V}^{[\tilde{r^*}(\emptyset)\theta_\emptyset + (1-\tilde{r^*}(\emptyset))\theta_B]V}(c - \theta_B V)dF(c)}{r^*(\emptyset)(\theta_\emptyset - \theta_B)}.$$

When $b \in [0, b_3')$, there is a $\underline{\beta}_3(b)$ such that $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \underline{\beta}_3(b), b] = 0$, $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] > 0$ for $\beta < \underline{\beta}_3(b)$ and $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] < 0$ for $\beta > \underline{\beta}_3(b)$.

Notice that $\chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = 0$ and $\tilde{h^*_B} = 1$ for any β when $\tilde{r^*}(\emptyset) = 0$. If $\tilde{r^*}(\emptyset) > 0$ and $b < b_3''$, we can show similarly that there exists a $\underline{\underline{\beta}}_3(b)$ such that $\chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \underline{\underline{\beta}}_3(b), b] = 0$ with $\chi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ positive or negative depending on whether β is less than or greater than $\underline{\underline{\beta}}_3(b)$. Given that the individual does not know which step he is at when he receives bad signal, he chooses $\tilde{h^*_B} = 1$ if $\beta > \max\{\underline{\beta}_3(b), \underline{\underline{\beta}}_3(b)\}$.

Similarly, when $s = \emptyset$,

$$\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}^{\beta(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset)V} (\theta_\emptyset V - c)dF(c) + b\{(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset) - [r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]\},$$

and $\hat{s} \neq \emptyset$ in equilibrium.

Let

$$b_3''' \equiv \frac{\int_{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}^{\beta(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset)V} (c - \theta_\emptyset V)dF(c)}{(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset) - [r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]}.$$

If we have

$$\int_{[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}^{(\frac{q-qp}{1-qp}\theta_G + \frac{1-q}{1-qp}\theta_\emptyset)V} (\theta_\emptyset V - c)dF(c) < 0,$$

i.e., p is close to 1, we can show that when $b \in [0, b_3''')$, there is a $\overline{\beta}_3(b)$ solving $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = 0$ such that $\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ is positive or negative depending on whether β is less than $\overline{\beta}_3(b)$ or greater than $\overline{\beta}_3(b)$. Thus, $h_\emptyset^* = 0$ if $\beta < \overline{\beta}_3(b)$. It follows that positive delusion equilibrium ($h_B^* = 1$, $h_\emptyset^* = 0$) exists if $\underline{\beta}_3(b) < \beta < \overline{\beta}_3(b)$ for $b < \min\{b_3', b_3'', b_3'''\}$.

Now we consider the intuitive criterion to refine this equilibrium. Note that this equilibrium is determined by the off-equilibrium belief $r^*(\emptyset)$. When $r^*(\emptyset) = 0$, self-B is indifferent between recall and amnesia. When $r^*(\emptyset) > 0$, he will choose to recall the bad signal for sufficiently large β. For type-$\emptyset$ self, regardless of the value of $r^*(\emptyset)$, delusion is always strictly better than correct recall when $\beta < \overline{\beta}_3(b)$. Thus after the equilibrium refinement under the intuitive criterion, self-1 knows that self-0 of type-$\emptyset$ will not correctly recall not having received a signal. Receiving such an empty signal precludes being type-$\emptyset$, so that the off-equilibrium-path belief $r^*(\emptyset)$ can only be zero. In this case, the individual is indifferent between correct recall and amnesia and would not need a large β to remain self truthful. Thus, when β is small enough, this equilibrium prevails.

(iv) Positive Confabulation with Delusion ($\tilde{h_B^*} = 0$, $\tilde{h_\emptyset^*} = 0$): We have $\tilde{r^*}(\emptyset)$ is arbitrary off-equilibrium belief and $\tilde{r^*}(G) = q - qp$. When $s = B$,

$$\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = \int_{\beta\theta_B V}^{\beta\theta^*(G)V} (\theta_B V - c)dF(c) + b[\theta^*(G) - \theta_B]$$
$$= \int_{\beta\theta_B V}^{\beta\theta_\emptyset V} (\theta_B V - c)dF(c) + b(\theta_\emptyset - \theta_B),$$

and $\hat{s} \neq B$ in equilibrium.

Let

$$b_4' \equiv \frac{\int_{\theta_B V}^{\theta_\emptyset V} (c - \theta_B V)dF(c)}{\theta_\emptyset - \theta_B}.$$

We similarly have that when $b \in [0, b'_4)$, there is a $\overline{\beta}_4(b)$ solving $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] = 0$ such that $\chi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ is positive or negative depending on whether β is less or greater than $\overline{\beta}_4(b)$. Thus, $\tilde{h^*_B} = 0$ if $\beta < \overline{\beta}_4(b)$. If $b \in (b'_4, +\infty)$, $\tilde{h^*_B} = 0$ for any β.

When $s = \emptyset$,

$$\begin{aligned}\Psi[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] &= \int_{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}^{\beta\theta^*(G)V} (\theta_\emptyset V - c)dF(c) + b\{\theta^*(G) - [r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B]\} \\ &= \int_{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}^{\beta\theta_\emptyset V} (\theta_\emptyset V - c)dF(c) + b[1 - r^*(\emptyset)](\theta_\emptyset - \theta_B)\end{aligned}$$

which is always positive. When $\hat{s} = \emptyset$,

$$\begin{aligned}\Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b] &= \int_{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset))\theta_B]V}^{\beta\theta^*(G)V} (\theta_B V - c)dF(c) + b\{\theta^*(G) - [r^*(\emptyset)\theta_\emptyset + (1 - r^*(\emptyset))\theta_B]\} \\ &= \int_{\beta[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset)\theta_B)]V}^{\beta\theta_\emptyset V} (\theta_B V - c)dF(c) + b[1 - r^*(\emptyset)](\theta_\emptyset - \theta_B).\end{aligned}$$

Let

$$b''_4 \equiv \frac{\int_{[r^*(\emptyset)\theta_\emptyset + (1-r^*(\emptyset)\theta_B)]V}^{\theta_\emptyset V} (c - \theta_B V)dF(c)}{[1 - r^*(\emptyset)](\theta_\emptyset - \theta_B)}.$$

We can show that when $b \in [0, b''_4)$, there exists $\overline{\overline{\beta}}_4(b)$ such that $\Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \overline{\overline{\beta}}_4(b), b] = 0$ and that $\Psi'[\tilde{r^*}(\emptyset), \tilde{r^*}(G), \beta, b]$ is positive for $\beta \in (0, \overline{\overline{\beta}}_4(b))$ and is negative for $\beta \in (\overline{\overline{\beta}}_4(b), 1]$, therefore $\tilde{h^*_\emptyset} = 0$ if $\beta < \overline{\overline{\beta}}_4(b)$; when $b \in (b''_4, +\infty)$, $\Psi[r^*(\emptyset), r^*(G), \beta_4, b]$ is always positive for any β, thus $\tilde{h^*_\emptyset}$ always equals 1. It follows that when $b < \min\{b'_4, b''_4\}$, PBE with positive confabulation without amnesia ($h^*_B = 0$, $h^*_\emptyset = 0$) exists if $\beta < \min\{\overline{\beta}_4(b), \overline{\overline{\beta}}_4(b)\}$; when $b \in (\min\{b'_4, b''_4\}, \max\{b'_4, b''_4\})$, the equilibrium exists when $\beta < \max\{\overline{\beta}_4(b), \overline{\overline{\beta}}_4(b)\}$; when $b > \max\{b'_4, b''_4\}$, this equilibrium always exists. Q.E.D.

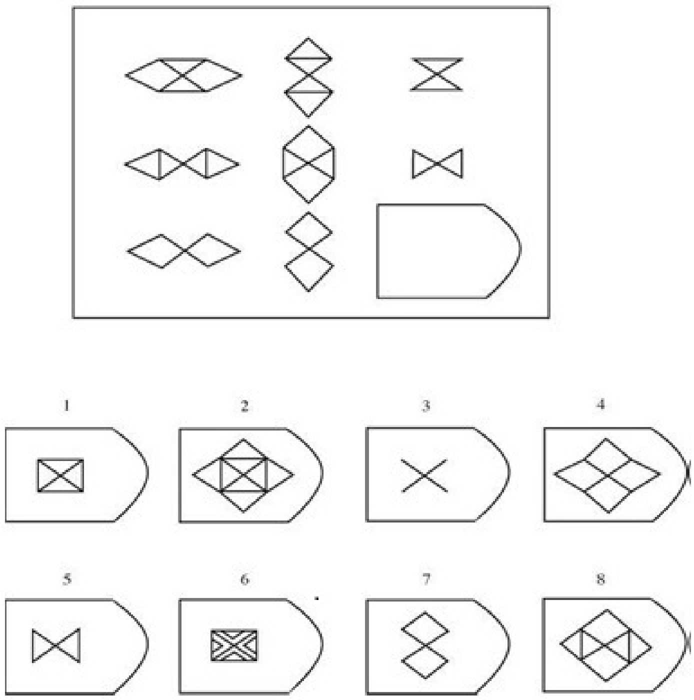
B Experimental Instruments

B.1 Memory Test on IQ Performance

Each subject comes across 6 memory tasks. Each memory task consists of a Ravens IQ question together with the correct answer. Subjects are asked to choose one of the options relating to their recall of their performance of the specific question. The specific wording used for each task is appended below. The actual Ravens questions used are displayed in the subsequent pages.

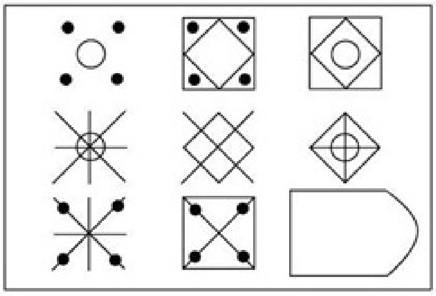
You are asked to recall your performance on some questions you may have attempted in Wave 1 of our study. After being presented with a question together with its correct answer, you can choose: a. My response was correct. b. My response was incorrect. c. I didn't see this question. d. I don't remember. You will receive $1 for a correct response or lose $1 for an incorrect response if you choose (a), (b), or (c). If you choose (d), you will receive $0.

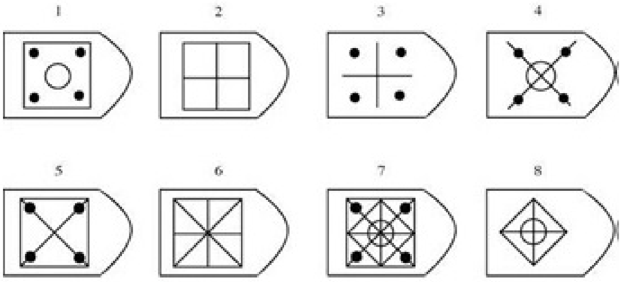
Question1



The correct answer is 3.

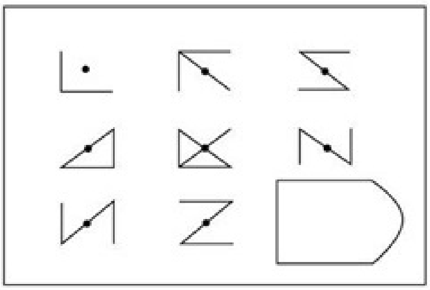
Question 2

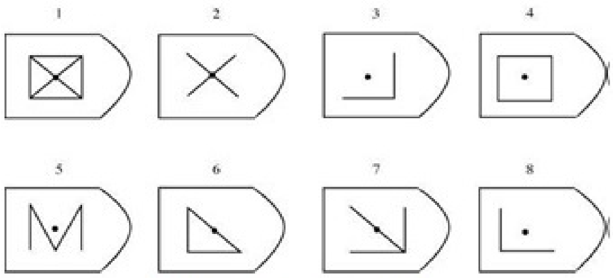




The correct answer is 2.

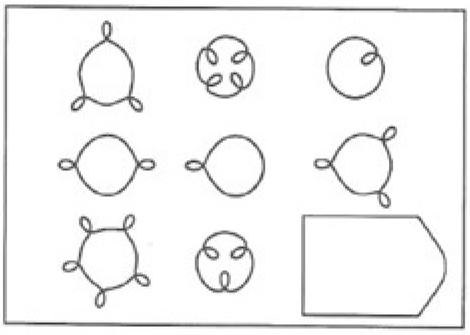
Question 3

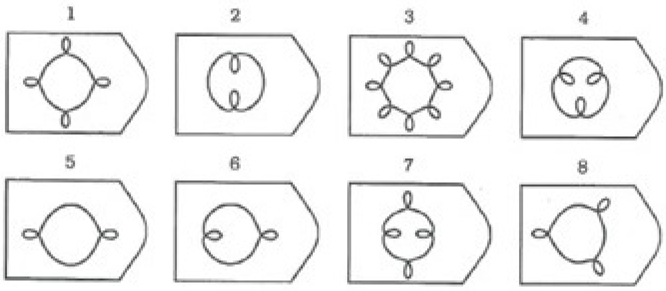




The correct answer is 4.

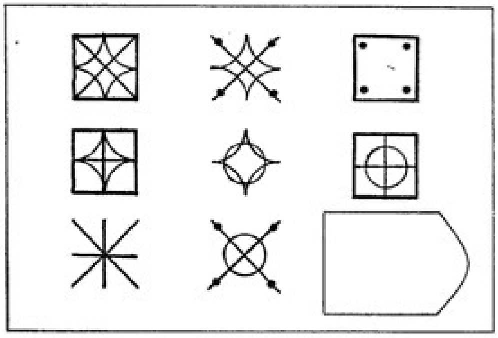
Question 4

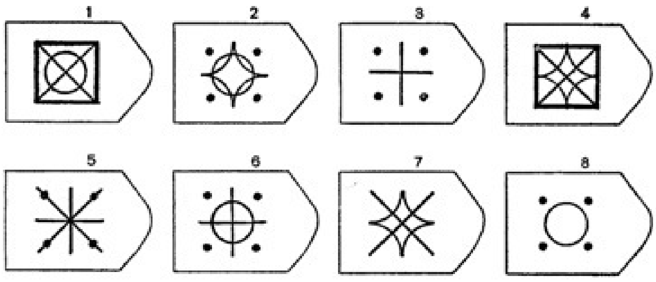




The correct answer is 5.

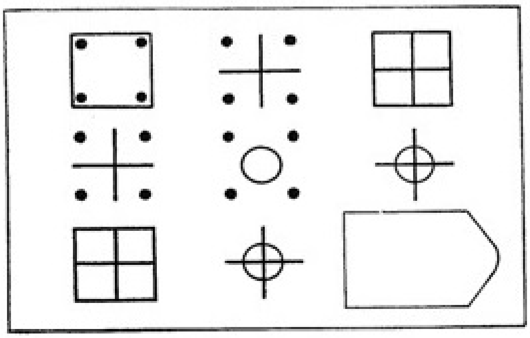
Question 5

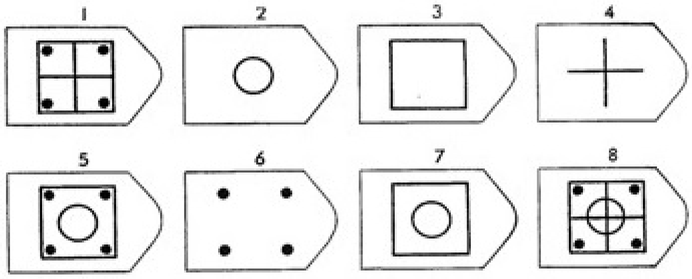




The correct answer is 6.

Question 6





The correct answer is 7.

B.2 Elicitation of Risk Attitude through a Portfolio Choice Task

The degree of risk aversion *ra* is assessed based on the subject's decisions on how much of a given amount of cash to allocate to purchasing a number of even-chance lottery which pays on average a positive amount. The actual task (appended) elicits one of 10 levels of risk aversion from holding all cash (coded as 1) to holding no cash (coded as 10).

In this task, you are endowed with $27. You have the option to invest an amount on an experimental stock constructed from a deck of 20 cards comprising 10 black cards and 10 red cards. For every dollar invested, you receive $2.5 if you guess the color of a randomly drawn card correctly. Otherwise, you receive $0 and lose your investment. The following table displays your investment options which consist of investing between $0 and $27 in steps of $3 in this experimental stock and keeping the rest as cash. The last two columns indicate your Total Earnings given by Cash + Investment Return for the cases of correct and incorrect guesses respectively.

DECISION: For the following 10 options, please indicate your decision with a tick (√).

Investment				**Total Earnings**	
	✓	**Cash**	**Invest**	**Correct Guess**	**Incorrect Guess**
1		$27.00	$0.00	$27.00	$27.00
2		$24.00	$3.00	$31.50	$24.00
3		$21.00	$6.00	$36.00	$21.00
4		$18.00	$9.00	$40.50	$18.00
5		$15.00	$12.00	$45.00	$15.00
6		$12.00	$15.00	$49.50	$12.00
7		$9.00	$18.00	$54.00	$9.00
8		$6.00	$21.00	$58.50	$6.00
9		$3.00	$24.00	$63.00	$3.00
10		$0.00	$27.00	$67.50	$0.00

B.3 Elicitation of Attitude towards Ambiguity

The degree of ambiguity aversion, aa, is assessed using the difference in certainty equivalents elicited for an even-chance lottery (deck of 10 red and 10 black cards) and for an ambiguous lottery (deck of 20 cards with unknown numbers of red and black cards). Using the switch point (where subjects' choices switch from Option A to Option B) for each lottery as proxy for its certainty equivalent, we can elicit a 21-level measure (from -10 to 10) of ambiguity aversion by subtracting the switch point for the ambiguous lottery from the switch point of the even-chance lottery. Higher value of aa corresponds to higher level of ambiguity aversion.

Even-chance Lottery[15]

This situation involves your guessing the color – red or black – of a card drawn randomly from a deck of 20 cards, comprising 10 black cards and 10 red cards.

Option A: You guess the color-black or red, and then draw a card from the 20 cards. If you make a correct guess, you receive \$60; otherwise, you receive nothing. That is: 50% chance of receiving \$60 and 50% chance of receiving \$0.

The Option B column lists the amounts you will receive for sure if you choose this option.

DECISION: For each of the 10 rows, please indicate your decision in the final column with a tick (√).

	Option A	**Option B**	**Decision**
1	50% of receiving \$60, 50% of receiving \$0	Receiving \$15 for sure	A ❑ B ❑
2	50% of receiving \$60, 50% of receiving \$0	Receiving \$19 for sure	A ❑ B ❑
3	50% of receiving \$60, 50% of receiving \$0	Receiving \$23 for sure	A ❑ B ❑
4	50% of receiving \$60, 50% of receiving \$0	Receiving \$25 for sure	A ❑ B ❑
5	50% of receiving \$60, 50% of receiving \$0	Receiving \$27 for sure	A ❑ B ❑
6	50% of receiving \$60, 50% of receiving \$0	Receiving \$29 for sure	A ❑ B ❑
7	50% of receiving \$60, 50% of receiving \$0	Receiving \$30 for sure	A ❑ B ❑
8	50% of receiving \$60, 50% of receiving \$0	Receiving \$31 for sure	A ❑ B ❑
9	50% of receiving \$60, 50% of receiving \$0	Receiving \$33 for sure	A ❑ B ❑
10	50% of receiving \$60, 50% of receiving \$0	Receiving \$35 for sure	A ❑ B ❑

[15] This lottery can also be used to elicit risk aversion. While it has been used to measure ambiguity aversion, in order to prevent the multicollinearity in regression, we apply a different lottery for risk attitude.

Ambiguous Lottery

This situation involves your drawing randomly one card from a deck of 20 cards with unknown proportions of red and black cards.

Option A: Guess the color of a card to be drawn randomly by you from a deck of 20 cards with unknown proportions of red and black cards. You will receive $60 if your guess is correct; and $0 otherwise.

The Option B column lists the amounts you can receive for sure if you choose this option.

DECISION: For each of the 10 rows, please indicate your decision in the final column with a tick (√).

	Option A	**Option B**	**Decision**
1	Betting on the color of a card drawn	Receiving $15 for sure	A ❏ B ❏
2	Betting on the color of a card drawn	Receiving $19 for sure	A ❏ B ❏
3	Betting on the color of a card drawn	Receiving $23 for sure	A ❏ B ❏
4	Betting on the color of a card drawn	Receiving $25 for sure	A ❏ B ❏
5	Betting on the color of a card drawn	Receiving $27 for sure	A ❏ B ❏
6	Betting on the color of a card drawn	Receiving $29 for sure	A ❏ B ❏
7	Betting on the color of a card drawn	Receiving $30 for sure	A ❏ B ❏
8	Betting on the color of a card drawn	Receiving $31 for sure	A ❏ B ❏
9	Betting on the color of a card drawn	Receiving $33 for sure	A ❏ B ❏
10	Betting on the color of a card drawn	Receiving $35 for sure	A ❏ B ❏

B.4 Elicitation of Time Preference through a Multiple List Task

The degree of time preference discount rates are elicited from comparisons between their tradeoffs in a proximal task (next day versus 31 days later) and a distal task (351 days versus 381 days later). The ratio of two values at the switch point (where subjects' choices switch from Option A to Option B) in distal task elicits normal discount rate δ, while the ratio of two values at the switch point in proximal task elicits near term discount rate $\beta\delta$. The ratio of two discount rates elicits the present bias β.

This task involves your choosing between receiving a sum of money on a specific day and another sum of money on another specific day. There are 20 choices to make. The first ten pairs of choices are about receiving $100 tomorrow versus receiving a larger amount 31 days later; the second ten pairs of choices are about receiving $100 in 351 days versus receiving a larger amount of money in 381 days. For this task, we will pay one randomly selected participant in this room at the end of today's study. For this participant, we will choose randomly one out of the 20 choices and pay him/her accordingly. Specifically, we will give him/her a cheque with the specified date at the end of today's experiment. Under Singapore banking practices, a cheque can be cashed only on or within 6 months of the date of the cheque. DECISION: For each of the 20 rows, please indicate your decision in the final column with a tick (√).

	A	Tomorrow	B	31 days later
1	❏	$100	❏	$101
2	❏	$100	❏	$104
3	❏	$100	❏	$107
4	❏	$100	❏	$110
5	❏	$100	❏	$113
6	❏	$100	❏	$116
7	❏	$100	❏	$119
8	❏	$100	❏	$122
9	❏	$100	❏	$125
10	❏	$100	❏	$128
	A	**351 days later**	**B**	**381 days later**
11	❏	$100	❏	$101
12	❏	$100	❏	$104
13	❏	$100	❏	$107
14	❏	$100	❏	$110
15	❏	$100	❏	$113
16	❏	$100	❏	$116
17	❏	$100	❏	$119
18	❏	$100	❏	$122
19	❏	$100	❏	$125
20	❏	$100	❏	$128

B.5 Measures of Attitudes towards Anticipatory Feelings and Uncertainty Resolution with Self-Image Concern

Question 1 and 2 involve timing of experiencing a good and a bad event respectively. They are used to measure subjects' attitudes toward anticipatory feelings. A longer (or shorter) realization time corresponds to a stronger sense of savoring for Q1 (or dread for Q2). Question 3 and 4 concerning the timing of resolving a positive or a negative uncertainty are used to measure subjects' attitudes toward uncertainty resolution related to self-image concern. According to our model, in Q3, the subject receives a good signal/impression of "ability", a delayed uncertainty resolution may suggest a stronger sense of savoring this signal. However, in Q4, the subject receives a bad signal concerning self-image. Thus, uncertainty resolution can be interpreted as "signal suppression" as a result of self-image maintenance.

1. Suppose you had the opportunity to have dinner with your favorite star. You could choose to have it today, or three days later. You would choose:

(1) Today; (2) 3 days later.

2. Suppose you had to take a non-lethal 110 volt shock. You could choose to take it today, or three months later. You would choose:

(1) Today; (2) 3 months later.

3. You have just taken a final examination and your next final exam for a different course will be in another 10 days. Your instructor expects to assign your final course grade in several days and offers each student the option to register for a SMS alert and be informed of your grade once it has been assigned. Suppose you feel like you have done well and when you look around, your peers look as if they have not done well. Which would you prefer?

(1) Sign up for the SMS alert and know your grade well ahead of your next final examination.
(2) Not sign up for the SMS alert and not know your grade until you receive both grades at the same time well after your second final examination.

4. You have just taken a final examination and your next final exam for a different course will be in another 10 days. Your instructor expects to assign your final course grade in several days and offers each student the option to register for a SMS alert and be informed of your grade once it has been assigned. Suppose you feel like you have done poorly and when you look around, your peers look as if they have done well. Which would you prefer?

(1) Sign up for the SMS alert and know your grade well ahead of your next final examination.
(2) Not sign up for the SMS alert and not know your grade until you receive both grades at the same time well after your second final examination.

C Statistical Results on Memory Patterns

Our statistical results on memory patterns are described in six sections. Section C.1 comprises several tables: Table 4 to 6 display the overall memory patterns in terms of the frequencies of each of four choices – a (*I did it right*), b (*I did it wrong*), c (*I did not see it before*), and d (*I don't remember*) – corresponding the 3 possible initial performance – correct, incorrect, and absent. Section C.2 contains Table 7 to 9 which compare positive and negative memory error proneness. Section C.3 compares the proportion of positive memory biases with the corresponding proportion of negative memory bias and shows that in each case, the frequency of positive memory bias is significantly higher than the corresponding frequency of negative memory bias. Table 10 to 12 in Section C.4 compares the proportions of positive delusion for Q5 and Q6 with the rates of correct response for Q1 – Q4 and shows that the proportion of positive delusion for each of Q5 and Q6 is significantly higher than each of the proportions of correct responses for Q1 to Q4. Table 13 to 15 in Section C.5 display the relation between positive delusion and positive confabulation. Section C.6 reports the results of probit regression of the various memory biases with respect to a number of factors including present bias, IQ, risk aversion, ambiguity aversion, gender, duration and group.

C.1 Overall memory patterns

Table 4: main sample

			Have seen it before								**Didn't see it or forgot**								
			a-did it right				**b-did it wrong**				**c-didn't see it**				**d-don't remember**				**Total**
Did appear	2804 66.7%	s=G	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	2076 49.4%
			396	366	305	281	30	35	25	22	40	37	15	9	142	143	125	105	
			9.4%	8.7%	7.3%	6.7%	0.7%	0.8%	0.6%	0.5%	1.0%	0.9%	0.4%	0.2%	3.4%	3.4%	3.0%	2.5%	
			1348 32%				112 2.7%				101 2.4%				515 12.2%				
		s=B	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	728 17.3%
			24	39	57	66	24	21	60	101	6	3	8	9	39	57	106	108	
			0.6%	0.9%	1.4%	1.6%	0.6%	0.5%	1.4%	2.4%	0.1%	0.1%	0.2%	0.2%	0.9%	1.4%	2.5%	2.6%	
			186 4.4%				206 4.9%				26 0.6%				310 7.4%				
Didn't appear	1402 33.3%	s=$\emptyset$	Q5		Q6		Q5		Q6		Q5		Q6		Q5		Q6		1402 33.3%
			394 9.4%		439 10.4%		30 0.7%		36 0.9%		60 1.4%		34 0.8%		217 5.2%		192 4.6%		
			833 19.8%				66 1.6%				94 2.2%				409 9.7%				
	4206 100%	Total	2367 56.3%				384 9.1%				221 5.3%				1234 29.3%				4206 100%
			2751 65%								1455 35%								

Table 5: replication sample

<table>
<tr><td></td><td></td><td></td><td colspan="8">Have seen it before</td><td colspan="8">Didn’t see it or forgot</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="4">a-did it right</td><td colspan="4">b-did it wrong</td><td colspan="4">c-didn’t see it</td><td colspan="4">d-don’t remember</td><td>Total</td></tr>
<tr><td rowspan="6">Did appear</td><td rowspan="6">1768
66.7%</td><td rowspan="3">s=G</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td rowspan="3">1282
48.3%</td></tr>
<tr><td>277
10.4%</td><td>258
9.7%</td><td>186
7.0%</td><td>140
5.3%</td><td>21
0.8%</td><td>17
0.6%</td><td>41
1.5%</td><td>33
1.2%</td><td>42
1.6%</td><td>27
1.0%</td><td>16
0.6%</td><td>29
1.1%</td><td>50
1.9%</td><td>58
2.2%</td><td>49
1.8%</td><td>38
1.4%</td></tr>
<tr><td colspan="4">861
32.5%</td><td colspan="4">112
4.2%</td><td colspan="4">114
4.3%</td><td colspan="4">195
7.4%</td></tr>
<tr><td rowspan="3">s=B</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td rowspan="3">486
18.3%</td></tr>
<tr><td>19
0.7%</td><td>44
1.7%</td><td>57
2.1%</td><td>71
2.7%</td><td>15
0.6%</td><td>11
0.4%</td><td>52
2.0%</td><td>48
1.8%</td><td>9
0.3%</td><td>4
0.2%</td><td>10
0.4%</td><td>34
1.3%</td><td>9
0.3%</td><td>23
0.9%</td><td>31
1.2%</td><td>49
1.8%</td></tr>
<tr><td colspan="4">191
7.2%</td><td colspan="4">126
4.8%</td><td colspan="4">57
2.1%</td><td colspan="4">112
4.2%</td></tr>
<tr><td rowspan="3">Didn’t appear</td><td rowspan="3">884
33.3%</td><td rowspan="3">s=$\emptyset$</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td rowspan="3">884
33.3%</td></tr>
<tr><td colspan="2">283
10.7%</td><td colspan="2">308
11.6%</td><td colspan="2">31
1.2%</td><td colspan="2">25
0.9%</td><td colspan="2">58
2.2%</td><td colspan="2">30
1.1%</td><td colspan="2">70
2.6%</td><td colspan="2">79
3.0%</td></tr>
<tr><td colspan="4">591
22.3%</td><td colspan="4">56
2.1%</td><td colspan="4">88
3.3%</td><td colspan="4">149
5.6%</td></tr>
<tr><td></td><td>2652
100%</td><td>Total</td><td colspan="4">1643
62.0%</td><td colspan="4">294
11.1%</td><td colspan="4">259
9.8%</td><td colspan="4">456
17.2%</td><td>2652
100%</td></tr>
<tr><td></td><td></td><td></td><td colspan="8">1947
73%</td><td colspan="8">729
43%</td><td></td></tr>
</table>

Table 6: pooled sample

<table>
<tr><td></td><td></td><td></td><td colspan="8">Have seen it before</td><td colspan="8">Didn't see it or forgot</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="4">a-did it right</td><td colspan="4">b-did it wrong</td><td colspan="4">c-didn't see it</td><td colspan="4">d-don't remember</td><td>Total</td></tr>
<tr><td rowspan="8">Did appear</td><td rowspan="8">4572
66.7%</td><td rowspan="4">s=G</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td rowspan="4">3358
49.0%</td></tr>
<tr><td>673</td><td>624</td><td>491</td><td>421</td><td>51</td><td>52</td><td>66</td><td>55</td><td>82</td><td>64</td><td>31</td><td>38</td><td>192</td><td>201</td><td>174</td><td>143</td></tr>
<tr><td>9.8%</td><td>9.1%</td><td>7.2%</td><td>6.1%</td><td>0.7%</td><td>0.8%</td><td>1.0%</td><td>0.8%</td><td>1.2%</td><td>0.9%</td><td>0.5%</td><td>0.6%</td><td>2.8%</td><td>2.9%</td><td>2.5%</td><td>2.1%</td></tr>
<tr><td colspan="4">2209
32.2%</td><td colspan="4">224
3.3%</td><td colspan="4">215
3.1%</td><td colspan="4">710
10.4%</td></tr>
<tr><td rowspan="4">s=B</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td rowspan="4">1214
17.7%</td></tr>
<tr><td>43</td><td>83</td><td>114</td><td>137</td><td>39</td><td>32</td><td>112</td><td>149</td><td>15</td><td>7</td><td>18</td><td>43</td><td>48</td><td>80</td><td>137</td><td>157</td></tr>
<tr><td>0.6%</td><td>1.2%</td><td>1.7%</td><td>2.0%</td><td>0.6%</td><td>0.5%</td><td>1.6%</td><td>2.2%</td><td>0.2%</td><td>0.1%</td><td>0.3%</td><td>0.6%</td><td>0.7%</td><td>1.2%</td><td>2.0%</td><td>2.3%</td></tr>
<tr><td colspan="4">377
5.5%</td><td colspan="4">332
4.8%</td><td colspan="4">83
1.2%</td><td colspan="4">422
6.2%</td></tr>
<tr><td rowspan="4">Didn't appear</td><td rowspan="4">2286
33.3%</td><td rowspan="4">s=$\emptyset$</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td colspan="2">Q5</td><td colspan="2">Q6</td><td rowspan="4">2286
33.3%</td></tr>
<tr><td colspan="2">677</td><td colspan="2">747</td><td colspan="2">61</td><td colspan="2">61</td><td colspan="2">118</td><td colspan="2">64</td><td colspan="2">287</td><td colspan="2">271</td></tr>
<tr><td colspan="2">10.7%</td><td colspan="2">11.6%</td><td colspan="2">1.2%</td><td colspan="2">0.9%</td><td colspan="2">2.2%</td><td colspan="2">1.1%</td><td colspan="2">2.6%</td><td colspan="2">3.0%</td></tr>
<tr><td colspan="4">1424
20.8%</td><td colspan="4">122
1.8%</td><td colspan="4">182
2.7%</td><td colspan="4">558
8.1%</td></tr>
<tr><td></td><td>6858
100%</td><td>Total</td><td colspan="4">4010
58.5%</td><td colspan="4">678
9.9%</td><td colspan="4">480
7.0%</td><td colspan="4">1690
24.6%</td><td>6858
100%</td></tr>
<tr><td></td><td></td><td></td><td colspan="8">2751
65%</td><td colspan="8">1455
35%</td><td></td></tr>
</table>

C.2 Comparing positive and negative memory error proneness. For each question, the displayed t-value and p-value apply to the difference between the rate of a positive bias and the rate of a negative bias.

Table 7: main sample

Q#	**Valence**	**Rate of Amnesia**	**Std. Err.**	**Std. Dev.**	t	p	**Rate of Confabulation**	**Std. Err.**	**Std. Dev.**	t	p
1	Positive	48.39%	0.057758	0.502448			25.81%	0.04562	0.439941		
	Negative	29.93%	0.018588	0.458347	3.569	0.0002	4.93%	0.008791	0.21676	7.2816	0.0000
2	Positive	50.00%	0.045835	0.502096			32.50%	0.042936	0.470339		
	Negative	30.98%	0.019201	0.462814	4.0379	0.0000	6.02%	0.00988	0.238138	9.0717	0.0000
3	Positive	49.35%	0.032966	0.501044			24.68%	0.028427	0.432058		
	Negative	29.79%	0.021117	0.45781	5.153	0.0000	5.32%	0.010363	0.224654	7.8037	0.0000
4	Positive	41.20%	0.029258	0.493059			23.24%	0.025107	0.423105		
	Negative	27.34%	0.021852	0.44623	3.8676	0.0000	5.28%	0.01096	0.223818	7.3004	0.0000
Overall	Positive	46.15%	0.018489	0.498861			25.55%	0.016176	0.436439		
	Negative	29.67%	0.010028	0.456924	8.1731	0.0000	5.39%	0.00496	0.225973	15.8421	0.0000

Table 8: replication sample

Q#	Valence	Rate of Amnesia	Std. Err.	Std. Dev.	*t*	*p*	Rate of Confabulation	Std. Err.	Std. Dev.	*t*	*p*
1	Positive	43.06%	0.0414069	0.4968823	3.8621	0.0001	29.66%	0.0380614	0.4583203	10.5197	0.0000
	Negative	27.45%	0.014134	0.4465105			5.11%	0.006974	0.2203166		
2	Positive	43.07%	0.0349268	0.4964035	4.1926	0.0000	41.09%	0.0347027	0.4932179	15.6468	0.0000
	Negative	28.16%	0.0146704	0.4500259			5.53%	0.0074524	0.2286093		
3	Positive	40.68%	0.0252002	0.4918875	4.7706	0.0000	29.92%	0.0234904	0.4585152	9.6669	0.0000
	Negative	26.9%	0.0160752	0.4437463			8.66%	0.010196	0.2814536		
4	Positive	41.15%	0.0223455	0.4926166	4.8685	0.0000	28.19%	0.02042990	0.4503851	9.173	0.0000
	Negative	27.55%	0.0174432	0.4471036			8.37%	0.0108134	0.2771692		
Overall	Positive	41.55%	0.0141555	0.4930111	9.0971	0.0000	31.05%	0.0132857	0.4629069	22.7288	0.0000
	Negative	27.55%	0.0077106	0.4468131			6.67%	0.0043064	0.24955		

Table 9: pooled sample

Q#	Valence	Rate of Amnesia	Std. Err.	Std. Dev.	*t*	*p*	Rate of Confabulation	Std. Err.	Std. Dev.	*t*	*p*
1	Positive	34.61%	0.0666173	0.4803845	1.7293	0.0422	36.53%	0.0674288	0.4862359	7.834	0.0000
	Negative	23.59%	0.021526	0.4251038			5.38%	0.0114441	0.2260038		
2	Positive	32.92%	0.0522164	0.4728395	1.7524	0.0402	53.66%	0.0554066	0.5017284	13.8688	0.0000
	Negative	23.61%	0.0224143	0.4252823			4.72%	0.0111949	0.2124091		
3	Positive	27.33%	0.0365108	0.4471636	1.182	0.1189	38.00%	0.0397644	0.4870125	5.9548	0.0000
	Negative	22.26%	0.024386	0.4167079			14.04%	0.0203657	0.3480093		
4	Positive	41.09%	0.0347027	0.4932179	2.9353	0.0018	35.14%	0.0336756	0.4786203	5.446	0.0000
	Negative	27.91%	0.0290168	0.4495271			13.75%	0.0222757	0.3450941		
Overall	Positive	34.77%	0.0216255	0.4767426	4.5337	0.0000	39.39%	0.0221779	0.488921	16.3248	0.0000
	Negative	24.10%	0.0119501	0.427875			8.73%	0.0078893	0.2824772		

C.3 Memory bias for replication and pooled samples

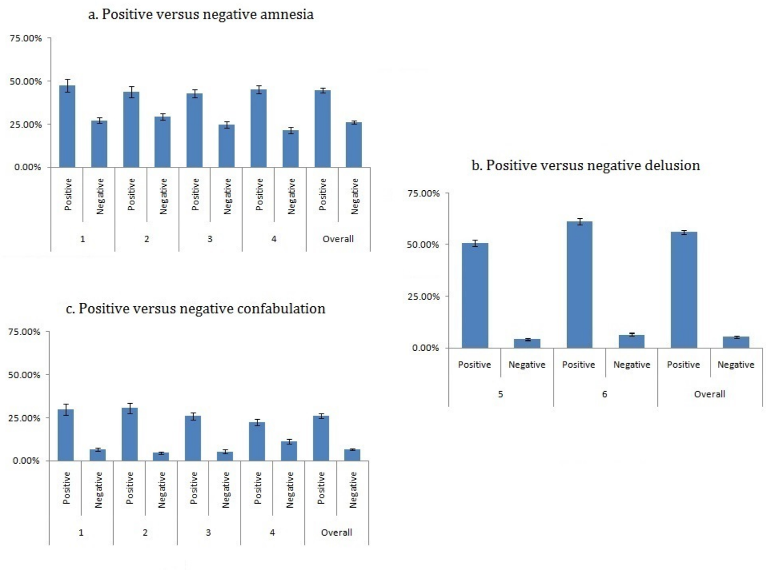


Figure 5: Replication sample

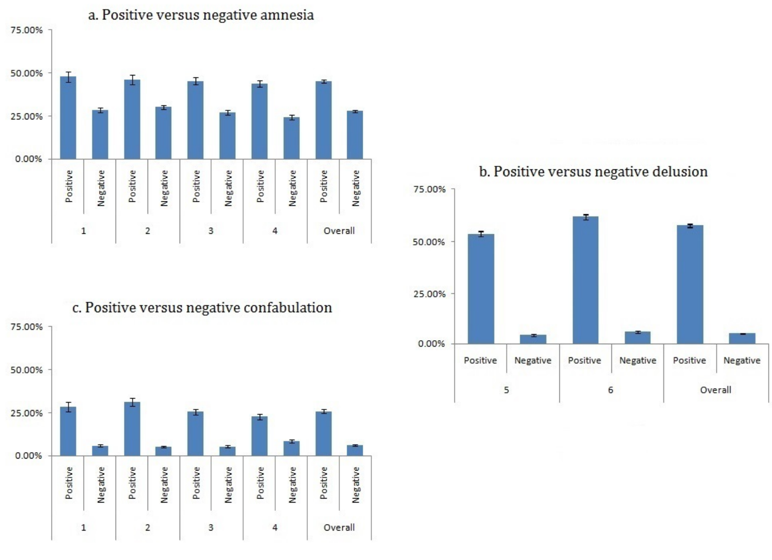


Figure 6: Pooled sample

C.4 Comparing positive and negative delusion

Table 10: main sample

		Rate of Correct Response			
		Question 1 *86.73%*	*Question 2* *82.88%*	*Question 3* *67.05%*	*Question 4* *59.49%*
Rate of Postive Delusion	*Question 5* 92.92%	0.0006	0.0000	0.0000	0.0000
	Question 6 92.42%	0.0011	0.0000	0.0000	0.0000

Table 11: replication sample

		Rate of Correct Response			
		Question 1 *88.24%*	*Question 2* *81.45%*	*Question 3* *66.06%*	*Question 4* *54.30%*
Rate of Postive Delusion	*Question 5* 90.13%	0.2064	0.0005	0.0000	0.0000
	Question 6 92.49%	0.0250	0.0000	0.0000	0.0000

Table 12: pooled sample

		Rate of Correct Response			
		Question 1 *87.31%*	*Question 2* *82.33%*	*Question 3* *66.67%*	*Question 4* *57.48%*
Rate of Postive Delusion	*Question 5* 91.73%	0.0014	0.0000	0.0000	0.0000
	Question 6 92.45%	0.0001	0.0000	0.0000	0.0000

C.5 Relation between positive delusion and positive confabulation

Table 13: main sample

Question	E9	E10	E11	E12	Question	N1	N2
Rate of Positive Confabulation With No Positive Delusion	26.67%	42.86%	36.67%	25.71%	**Rate of Positive Delusion with Positive Confabulation**	73.19%	78.36%
Rate of Unconditional Positive Confabulation	50.00%	65.00%	48.72%	39.52%	**Rate of Unconditional Positive Delusion**	58.72%	66.02%
***p*-value**	0.058	0.065	0.1202	0.0627	***p*-value**	0.0007	0.0026

Table 14: replication sample

Question	E9	E10	E11	E12	Question	N1	N2
Rate of Positive Confabulation With No Positive Delusion	23.52%	16.00%	21.28%	21.43%	**Rate of Positive Delusion with Positive Confabulation**	68.57%	78.57%
Rate of Unconditional Positive Confabulation	36.54%	53.66%	38.00%	35.15%	**Rate of Unconditional Positive Delusion**	64.03%	69.68%
***p*-value**	0.1652	0.0004	0.0174	0.026	***p*-value**	0.1632	0.0209

Table 15: pooled sample

Question	E9	E10	E11	E12	Question	N1	N2
Rate of Positive Confabulation With No Positive Delusion	12.70%	11.36%	14.38%	13.64%	**Rate of Positive Delusion with Positive Confabulation**	69.12%	75.34%
Rate of Unconditional Positive Confabulation	29.66%	41.09%	29.92%	28.19%	**Rate of Unconditional Positive Delusion**	59.23%	65.35%
***p*-value**	0.0044	0.0000	0.000	0.0001	***p*-value**	0.0011	0.0006

C.6 Probit Regression on Memory Patterns

Table 16: Positive Amnesia: Question 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	-0.354	-0.215	-0.268	-0.185	-0.232	-0.0812	-0.140	-0.0303	-0.119	-0.0482	0.194
	(1.578)	(1.576)	(1.641)	(1.612)	(1.591)	(1.675)	(1.718)	(1.695)	(1.678)	(1.692)	(1.783)
δ		0.642	0.687	0.868	0.843	0.626	0.651	0.780	0.778	0.447	0.372
		(1.952)	(1.919)	(1.928)	(1.940)	(2.049)	(2.031)	(2.038)	(2.059)	(1.945)	(2.043)
paf		0.206				0.173				0.103	0.0884
		(0.334)				(0.329)				(0.356)	(0.347)
naf			-0.341				-0.309			-0.340	-0.317
			(0.281)				(0.286)			(0.300)	(0.300)
pur				-0.102				-0.144		-0.227	-0.292
				(0.270)				(0.275)		(0.358)	(0.358)
nur					0.0261				0.0231	0.193	0.240
					(0.288)				(0.296)	(0.375)	(0.382)
ra						-0.0255	-0.0231	-0.0255	-0.0252		-0.0243
						(0.0581)	(0.0600)	(0.0582)	(0.0585)		(0.0597)
aa						-0.0188	-0.0196	-0.0196	-0.0180		-0.0244
						(0.0478)	(0.0481)	(0.0481)	(0.0478)		(0.0491)
female						0.226	0.217	0.218	0.216		0.246
						(0.292)	(0.293)	(0.294)	(0.293)		(0.298)
duration						-0.00125	-0.00120	-0.00150	-0.00143		-0.00110
						(0.00176)	(0.00179)	(0.00179)	(0.00176)		(0.00183)
Singapore						-0.283	-0.252	-0.351	-0.322		-0.260
						(0.387)	(0.392)	(0.391)	(0.386)		(0.396)
Constant	0.00297	-1.112	-0.269	-0.832	-0.960	-0.620	0.107	-0.170	-0.380	-0.418	-0.0761
	(1.552)	(2.554)	(2.543)	(2.466)	(2.484)	(2.712)	(2.621)	(2.586)	(2.602)	(2.712)	(2.796)
Observations	93	93	93	93	93	93	93	93	93	93	93
Pseudo R^2	0.000388	0.00507	0.0143	0.00315	0.00203	0.0201	0.0277	0.0204	0.0181	0.0189	0.0340

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 17: Positive Amnesia: Question 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	1.606	1.298	1.531	1.591	1.525	1.351	1.618	1.743	1.617	1.492	1.803
	(1.452)	(1.461)	(1.459)	(1.470)	(1.457)	(1.552)	(1.597)	(1.628)	(1.587)	(1.530)	(1.657)
δ		-0.296	-0.418	-0.468	-0.428	0.601	0.586	0.590	0.665	-0.0943	0.942
		(1.755)	(1.813)	(1.814)	(1.836)	(1.769)	(1.805)	(1.788)	(1.832)	(1.809)	(1.859)
paf		-0.485*				-0.470*				-0.532*	-0.506*
		(0.283)				(0.286)				(0.294)	(0.297)
naf			-0.0724				0.00505			-0.170	-0.0480
			(0.283)				(0.288)			(0.298)	(0.303)
pur				-0.0787				-0.130		-0.210	-0.416
				(0.262)				(0.267)		(0.346)	(0.368)
nur					0.0638				0.133	0.241	0.446
					(0.273)				(0.274)	(0.362)	(0.374)
ra						-0.0867	-0.0964*	-0.0974*	-0.101*		-0.106*
						(0.0563)	(0.0576)	(0.0584)	(0.0573)		(0.0617)
aa						-0.00733	-0.00749	-0.0131	-0.00521		-0.0195
						(0.0445)	(0.0462)	(0.0450)	(0.0459)		(0.0441)
female						0.252	0.268	0.270	0.256		0.221
						(0.277)	(0.279)	(0.280)	(0.282)		(0.282)
duration						-0.00271	-0.00236	-0.00235	-0.00235		-0.00266
						(0.00209)	(0.00207)	(0.00215)	(0.00210)		(0.00206)
Singapore						-0.399	-0.283	-0.287	-0.268		-0.372
						(0.436)	(0.430)	(0.445)	(0.440)		(0.436)
Constant	-2.265	-0.848	-1.699	-1.690	-1.882	-0.564	-1.751	-1.663	-2.025	-1.015	-1.210
	(1.445)	(2.345)	(2.430)	(2.426)	(2.572)	(2.550)	(2.653)	(2.702)	(2.824)	(2.675)	(2.917)
Observations	111	111	111	111	111	111	111	111	111	111	111
Pseudo R^2	0.00764	0.0308	0.00865	0.00885	0.00858	0.0770	0.0576	0.0593	0.0593	0.0379	0.0900

Note: Robust standard errors in parentheses, *** $p<0.01$, **$p<0.05$, * $p<0.1$

Table 18: Positive Amnesia: Question 3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	-1.057	-0.912	-1.025	-0.902	-0.918	-0.638	-0.783	-0.614	-0.654	-1.022	-0.746
	(0.984)	(1.016)	(1.010)	(1.013)	(1.013)	(1.057)	(1.053)	(1.056)	(1.055)	(1.023)	(1.068)
δ		1.967	1.984	1.941	1.942	1.422	1.451	1.408	1.417	1.990	1.426
		(1.221)	(1.211)	(1.215)	(1.215)	(1.264)	(1.254)	(1.259)	(1.260)	(1.220)	(1.262)
paf		-0.156				-0.195				-0.116	-0.157
		(0.195)				(0.200)				(0.199)	(0.205)
naf			0.239				0.234			0.221	0.214
			(0.183)				(0.185)			(0.186)	(0.189)
pur				-0.0408				-0.0687		0.0227	-0.0360
				(0.161)				(0.164)		(0.203)	(0.209)
nur					-0.0992				-0.0732	-0.104	-0.0426
					(0.168)				(0.171)	(0.211)	(0.218)
ra						-0.0286	-0.0305	-0.0317	-0.0285		-0.0290
						(0.0362)	(0.0358)	(0.0363)	(0.0362)		(0.0373)
aa						0.0244	0.0255	0.0236	0.0237		0.0255
						(0.0264)	(0.0268)	(0.0265)	(0.0264)		(0.0267)
female						0.0643	0.0625	0.0534	0.0588		0.0642
						(0.169)	(0.169)	(0.168)	(0.168)		(0.169)
duration						6.94e-05	2.95e-05	7.80e-05	6.47e-05		-5.23e-05
						(0.00106)	(0.00107)	(0.00106)	(0.00106)		(0.00108)
Singapore						-0.456**	-0.440*	-0.445*	-0.440*		-0.465**
						(0.231)	(0.232)	(0.231)	(0.230)		(0.233)
Constant	0.795	-0.937	-1.425	-1.139	-1.023	-0.268	-0.792	-0.507	-0.480	-1.067	-0.347
	(0.964)	(1.640)	(1.618)	(1.631)	(1.638)	(1.739)	(1.708)	(1.739)	(1.744)	(1.675)	(1.777)
Observations	251	251	251	251	251	251	251	251	251	251	251
Pseudo R^2	0.00335	0.0129	0.0161	0.0112	0.0120	0.0361	0.0380	0.0338	0.0338	0.0181	0.0405

Note: Robust standard errors in parentheses, *** p<0.01, **p<0.05, * p<0.1

Table 19: Positive Amnesia: Question 4

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	0.581	0.667	0.658	0.755	0.622	0.446	0.441	0.551	0.401	0.656	0.415
	(0.910)	(0.931)	(0.931)	(0.924)	(0.917)	(0.956)	(0.955)	(0.953)	(0.945)	(0.923)	(0.956)
δ		1.437	1.456	1.382	1.398	1.893*	1.937*	1.830*	1.842*	1.418	1.876*
		(1.048)	(1.049)	(1.049)	(1.049)	(1.044)	(1.046)	(1.046)	(1.051)	(1.054)	(1.053)
paf		-0.100				-0.0462				-0.0869	-0.0425
		(0.177)				(0.180)				(0.180)	(0.182)
naf			-0.0818				-0.104			-0.0695	-0.0916
			(0.165)				(0.168)			(0.165)	(0.169)
pur				-0.247*				-0.209		-0.0520	-0.00955
				(0.142)				(0.146)		(0.194)	(0.201)
nur					-0.331**				-0.308**	-0.288	-0.296
					(0.146)				(0.148)	(0.199)	(0.205)
ra						-0.0185	-0.0194	-0.0203	-0.0175		-0.0171
						(0.0302)	(0.0302)	(0.0303)	(0.0303)		(0.0306)
aa						-0.0243	-0.0262	-0.0261	-0.0244		-0.0261
						(0.0227)	(0.0229)	(0.0228)	(0.0227)		(0.0229)
female						0.0722	0.0753	0.0828	0.0740		0.0795
						(0.147)	(0.147)	(0.147)	(0.148)		(0.148)
duration						0.000732	0.000711	0.000636	0.000554		0.000532
						(0.000819)	(0.000819)	(0.000820)	(0.000823)		(0.000824)
Singapore						0.442**	0.441**	0.398**	0.414**		0.406**
						(0.192)	(0.191)	(0.194)	(0.192)		(0.195)
Constant	-0.769	-2.041	-2.130	-1.882	-1.604	-2.732*	-2.709*	-2.479*	-2.165	-1.402	-2.014
	(0.895)	(1.451)	(1.433)	(1.429)	(1.442)	(1.458)	(1.436)	(1.434)	(1.449)	(1.481)	(1.496)
Observations	323	323	323	323	323	323	323	323	323	323	323
Pseudo R^2	0.000903	0.00599	0.00585	0.0122	0.0170	0.0252	0.0259	0.0297	0.0348	0.0180	0.0356

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 20: Positive Amnesia: Overall

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	-0.0780	0.0197	0.0339	0.0833	0.00563	0.119	0.134	0.204	0.0961	0.0294	0.158
	(0.562)	(0.575)	(0.573)	(0.575)	(0.573)	(0.591)	(0.590)	(0.594)	(0.590)	(0.581)	(0.602)
δ		1.275*	1.250*	1.223*	1.234*	1.428**	1.426**	1.385**	1.395**	1.262*	1.404**
		(0.678)	(0.678)	(0.678)	(0.677)	(0.686)	(0.687)	(0.686)	(0.687)	(0.680)	(0.688)
paf		-0.124				-0.111				-0.121	-0.110
		(0.111)				(0.112)				(0.114)	(0.115)
naf			-0.0349				-0.0419			-0.0469	-0.0518
			(0.103)				(0.103)			(0.105)	(0.105)
pur				-0.128				-0.145		-0.0484	-0.0846
				(0.0919)				(0.0932)		(0.122)	(0.124)
nur					-0.159*				-0.149	-0.121	-0.0881
					(0.0950)				(0.0958)	(0.125)	(0.127)
ra						-0.0323	-0.0337*	-0.0352*	-0.0316		-0.0317
						(0.0198)	(0.0198)	(0.0199)	(0.0198)		(0.0201)
aa						-0.00740	-0.00796	-0.00882	-0.00765		-0.00892
						(0.0151)	(0.0151)	(0.0151)	(0.0151)		(0.0151)
female						0.0959	0.0955	0.0963	0.0972		0.0995
						(0.0953)	(0.0953)	(0.0955)	(0.0955)		(0.0956)
duration						1.75e-05	5.34e-05	-2.14e-05	-3.99e-05		-6.48e-05
						(0.000564)	(0.000565)	(0.000567)	(0.000567)		(0.000567)
Singapore						-0.0320	-0.0174	-0.0450	-0.0338		-0.0541
						(0.127)	(0.127)	(0.128)	(0.127)		(0.128)
Constant	-0.214	-1.301	-1.468	-1.342	-1.211	-1.417	-1.586*	-1.403	-1.306	-0.974	-1.063
	(0.554)	(0.922)	(0.912)	(0.912)	(0.922)	(0.947)	(0.935)	(0.937)	(0.950)	(0.947)	(0.976)
Observations	778	778	778	778	778	778	778	778	778	778	778
Pseudo R^2	1.76e-05	0.00449	0.00342	0.00520	0.00600	0.00899	0.00821	0.0104	0.0104	0.00737	0.0119

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 21: Positive Delusion: Question 5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	1.077**	0.972*	0.956*	0.960*	0.971*	0.747	0.728	0.729	0.749	0.977*	0.748
	(0.511)	(0.517)	(0.518)	(0.517)	(0.519)	(0.523)	(0.523)	(0.523)	(0.524)	(0.519)	(0.525)
δ		-0.898	-0.899	-0.889	-0.895	-0.751	-0.743	-0.725	-0.738	-0.892	-0.737
		(0.573)	(0.573)	(0.573)	(0.573)	(0.576)	(0.576)	(0.576)	(0.576)	(0.574)	(0.577)
paf		-0.164*				-0.126				-0.172*	-0.134
		(0.0956)				(0.0972)				(0.0963)	(0.0978)
naf			-0.0423				-0.0402			-0.0608	-0.0555
			(0.0927)				(0.0931)			(0.0933)	(0.0937)
pur				0.0295				0.0527		0.0188	0.0452
				(0.0805)				(0.0812)		(0.104)	(0.106)
nur					0.0267				0.0396	0.0239	0.0161
					(0.0825)				(0.0830)	(0.107)	(0.108)
ra						-0.0201	-0.0218	-0.0214	-0.0220		-0.0201
						(0.0173)	(0.0173)	(0.0173)	(0.0173)		(0.0173)
aa						0.0179	0.0178	0.0180	0.0176		0.0182
						(0.0129)	(0.0129)	(0.0129)	(0.0129)		(0.0129)
female						-0.0332	-0.0444	-0.0450	-0.0463		-0.0342
						(0.0816)	(0.0812)	(0.0811)	(0.0812)		(0.0818)
duration						0.000623	0.000616	0.000634	0.000632		0.000619
						(0.000481)	(0.000481)	(0.000479)	(0.000480)		(0.000482)
Singapore						0.334***	0.345***	0.352***	0.348***		0.336***
						(0.108)	(0.108)	(0.108)	(0.108)		(0.109)
Constant	-1.368***	-0.125	-0.345	-0.457	-0.459	-0.405	-0.557	-0.717	-0.700	-0.111	-0.430
	(0.500)	(0.805)	(0.798)	(0.804)	(0.808)	(0.831)	(0.826)	(0.830)	(0.833)	(0.833)	(0.861)
Observations	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014
Pseudo R^2	0.00329	0.00732	0.00528	0.00522	0.00520	0.0173	0.0161	0.0163	0.0162	0.00779	0.0179

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 22: Positive Delusion: Question 6

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	1.239**	1.178**	1.175**	1.170**	1.170**	1.062**	1.061**	1.051**	1.060**	1.161**	1.038**
	(0.519)	(0.526)	(0.526)	(0.525)	(0.527)	(0.528)	(0.528)	(0.527)	(0.530)	(0.527)	(0.529)
δ		-0.500	-0.503	-0.495	-0.503	-0.361	-0.361	-0.348	-0.359	-0.488	-0.346
		(0.601)	(0.601)	(0.600)	(0.600)	(0.599)	(0.599)	(0.599)	(0.599)	(0.601)	(0.599)
paf		-0.0604				-0.0252				-0.0517	-0.0168
		(0.0978)				(0.0996)				(0.0984)	(0.100)
naf			0.0916				0.0864			0.0865	0.0847
			(0.0939)				(0.0942)			(0.0943)	(0.0946)
pur				0.0372				0.0481		0.0673	0.0748
				(0.0827)				(0.0833)		(0.107)	(0.109)
nur					-0.00378				0.00708	-0.0468	-0.0426
					(0.0848)				(0.0851)	(0.110)	(0.112)
ra						-0.0353**	-0.0350*	-0.0352**	-0.0357**		-0.0338*
						(0.0179)	(0.0179)	(0.0179)	(0.0179)		(0.0179)
aa						0.00701	0.00653	0.00702	0.00697		0.00676
						(0.0132)	(0.0133)	(0.0133)	(0.0133)		(0.0132)
female						0.000485	-0.00209	-0.00312	-0.00218		-0.000226
						(0.0841)	(0.0837)	(0.0836)	(0.0836)		(0.0843)
duration						0.000504	0.000518	0.000510	0.000505		0.000521
						(0.000482)	(0.000482)	(0.000482)	(0.000482)		(0.000482)
Singapore						0.268**	0.273**	0.275**	0.271**		0.277**
						(0.111)	(0.110)	(0.111)	(0.110)		(0.111)
Constant	-1.701***	-1.060	-1.277	-1.220	-1.150	-1.271	-1.431*	-1.396	-1.327	-1.207	-1.446
	(0.508)	(0.841)	(0.837)	(0.841)	(0.845)	(0.858)	(0.857)	(0.860)	(0.863)	(0.871)	(0.892)
Observations	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,010
Pseudo R^2	0.00445	0.00534	0.00579	0.00519	0.00503	0.0136	0.0142	0.0138	0.0136	0.00632	0.0146

Note: Robust standard errors in parentheses, *** $p<0.01$, **$p<0.05$, * $p<0.1$

Table 23: Positive Delusion: Question 5+6

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	1.164***	1.079***	1.071***	1.070***	1.075***	0.904**	0.895**	0.889**	0.904**	1.075***	0.893**
	(0.363)	(0.367)	(0.367)	(0.367)	(0.368)	(0.370)	(0.370)	(0.370)	(0.371)	(0.368)	(0.371)
δ		-0.705*	-0.707*	-0.699*	-0.707*	-0.560	-0.555	-0.541	-0.553	-0.693*	-0.543
		(0.414)	(0.413)	(0.413)	(0.413)	(0.414)	(0.413)	(0.414)	(0.413)	(0.414)	(0.414)
paf		-0.113*				-0.0753				-0.112	-0.0749
		(0.0682)				(0.0693)				(0.0686)	(0.0697)
naf			0.0227				0.0210			0.0111	0.0129
			(0.0659)				(0.0662)			(0.0663)	(0.0665)
pur				0.0346				0.0517		0.0454	0.0624
				(0.0576)				(0.0581)		(0.0744)	(0.0757)
nur					0.0124				0.0242	-0.0128	-0.0148
					(0.0590)				(0.0593)	(0.0764)	(0.0774)
ra						-0.0274**	-0.0282**	-0.0280**	-0.0286**		-0.0268**
						(0.0124)	(0.0124)	(0.0124)	(0.0124)		(0.0124)
aa						0.0124	0.0122	0.0125	0.0122		0.0126
						(0.00923)	(0.00925)	(0.00926)	(0.00925)		(0.00924)
female						-0.0174	-0.0241	-0.0251	-0.0254		-0.0179
						(0.0585)	(0.0581)	(0.0581)	(0.0581)		(0.0585)
duration						0.000565*	0.000571*	0.000574*	0.000570*		0.000574*
						(0.000340)	(0.000340)	(0.000339)	(0.000339)		(0.000340)
Singapore						0.302***	0.311***	0.315***	0.311***		0.308***
						(0.0772)	(0.0769)	(0.0772)	(0.0769)		(0.0777)
Constant	-1.539***	-0.590	-0.807	-0.837	-0.802	-0.835	-0.990*	-1.054*	-1.009*	-0.659	-0.938
	(0.355)	(0.579)	(0.575)	(0.578)	(0.581)	(0.594)	(0.591)	(0.594)	(0.597)	(0.599)	(0.616)
Observations	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025
Pseudo R^2	0.00390	0.00608	0.00508	0.00517	0.00505	0.0148	0.0144	0.0146	0.0144	0.00627	0.0151

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 24: Positive Confabulation: Question 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	3.149	3.753*	3.619*	3.426*	3.390*	3.395	3.220	3.044	2.993	3.840*	3.525*
	(1.951)	(2.045)	(1.969)	(1.941)	(1.979)	(2.114)	(2.047)	(2.003)	(2.049)	(2.023)	(2.103)
δ		3.370*	3.324*	2.836	2.893	4.324**	4.302*	3.902*	3.970*	3.747*	4.531**
		(1.886)	(1.990)	(1.919)	(1.914)	(2.157)	(2.316)	(2.196)	(2.193)	(1.970)	(2.262)
paf		-0.332				-0.311				-0.369	-0.358
		(0.418)				(0.432)				(0.439)	(0.458)
naf			0.397				0.369			0.408	0.379
			(0.354)				(0.356)			(0.358)	(0.363)
pur				-0.207				-0.180		-0.268	-0.253
				(0.300)				(0.304)		(0.374)	(0.385)
nur					-0.129				-0.119	0.0303	0.0385
					(0.334)				(0.343)	(0.418)	(0.435)
ra						-0.0343	-0.0367	-0.0383	-0.0362		-0.0324
						(0.0749)	(0.0726)	(0.0731)	(0.0737)		(0.0728)
aa						0.0178	0.0179	0.0157	0.0167		0.0134
						(0.0475)	(0.0478)	(0.0474)	(0.0477)		(0.0485)
female						-0.168	-0.108	-0.123	-0.107		-0.173
						(0.349)	(0.348)	(0.345)	(0.346)		(0.363)
duration						0.000941	0.00113	0.00107	0.00112		0.000731
						(0.00206)	(0.00213)	(0.00216)	(0.00214)		(0.00208)
Singapore						0.386	0.414	0.411	0.441		0.315
						(0.448)	(0.448)	(0.454)	(0.447)		(0.448)
Constant	-3.126*	-6.284**	-7.214**	-5.750**	-5.871**	-7.097**	-8.033**	-6.701**	-6.852**	-6.799**	-7.379**
	(1.891)	(2.685)	(2.816)	(2.631)	(2.788)	(3.144)	(3.414)	(3.139)	(3.346)	(2.864)	(3.494)
Observations	73	73	73	73	73	73	73	73	73	73	73
Pseudo R^2	0.0226	0.0493	0.0556	0.0479	0.0447	0.0618	0.0675	0.0602	0.0580	0.0683	0.0778

Note: Robust standard errors in parentheses, *** $p<0.01$, **$p<0.05$, * $p<0.1$

Table 25: Positive Confabulation: Question 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	6.161**	6.088**	6.151**	6.572**	6.442**	8.740***	8.475***	8.773***	8.633***	6.549***	9.001***
	(2.582)	(2.511)	(2.575)	(2.578)	(2.587)	(2.651)	(2.558)	(2.559)	(2.482)	(2.513)	(2.604)
δ		0.826	-0.0491	-0.261	-0.0876	3.045	2.416	2.011	2.365	0.849	2.655
		(2.034)	(2.124)	(2.200)	(2.067)	(2.112)	(2.113)	(2.136)	(2.107)	(2.061)	(2.133)
paf		-0.620**				-0.577*				-0.659**	-0.582*
		(0.297)				(0.329)				(0.310)	(0.337)
naf			-0.0766				0.0899			-0.129	0.0258
			(0.295)				(0.329)			(0.330)	(0.357)
pur				-0.599**				-0.395		-0.589*	-0.437
				(0.279)				(0.307)		(0.316)	(0.344)
nur					-0.284				-0.143	-0.0392	0.0636
					(0.291)				(0.312)	(0.337)	(0.358)
ra						-0.140*	-0.158**	-0.146*	-0.152**		-0.129
						(0.0742)	(0.0732)	(0.0781)	(0.0750)		(0.0801)
aa						-0.0786	-0.0700	-0.0840	-0.0742		-0.0902*
						(0.0538)	(0.0543)	(0.0549)	(0.0545)		(0.0532)
female						0.540*	0.555*	0.471	0.543*		0.450
						(0.317)	(0.316)	(0.323)	(0.315)		(0.326)
duration						-0.00717***	-0.00690**	-0.00635**	-0.00674**		-0.00667**
						(0.00274)	(0.00282)	(0.00288)	(0.00292)		(0.00263)
Singapore						-0.421	-0.345	-0.269	-0.316		-0.365
						(0.536)	(0.547)	(0.561)	(0.566)		(0.524)
Constant	-6.588***	-6.225**	-6.432**	-5.805*	-6.309**	-8.364***	-8.681***	-8.027***	-8.506***	-5.483*	-7.840**
	(2.512)	(3.111)	(3.193)	(3.260)	(3.215)	(3.055)	(3.068)	(3.112)	(3.042)	(3.246)	(3.244)
Observations	99	99	99	99	99	99	99	99	99	99	99
Pseudo R^2	0.0891	0.120	0.0897	0.126	0.0968	0.286	0.266	0.278	0.267	0.159	0.298

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 26: Positive Confabulation: Question 3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	-1.021	-0.887	-1.010	-0.912	-0.890	-1.038	-1.163	-1.052	-1.031	-1.009	-1.148
	(0.983)	(1.000)	(0.998)	(1.003)	(1.006)	(1.003)	(1.000)	(1.004)	(1.009)	(1.006)	(1.010)
δ		2.072	2.113*	2.070	2.071	2.154*	2.220*	2.151*	2.161*	2.117*	2.224*
		(1.269)	(1.262)	(1.267)	(1.267)	(1.281)	(1.273)	(1.282)	(1.279)	(1.262)	(1.270)
paf		-0.0419				-0.0317				0.00186	0.0171
		(0.209)				(0.213)				(0.213)	(0.217)
naf			0.316				0.328			0.330	0.345
			(0.205)				(0.207)			(0.209)	(0.210)
pur				-0.0923				-0.0709		-0.175	-0.164
				(0.177)				(0.180)		(0.227)	(0.231)
nur					-0.000720				0.0181	0.0985	0.108
					(0.183)				(0.184)	(0.233)	(0.234)
ra						-0.0197	-0.0253	-0.0209	-0.0206		-0.0287
						(0.0396)	(0.0398)	(0.0396)	(0.0395)		(0.0401)
aa						0.00595	0.00148	0.00581	0.00611		0.00114
						(0.0285)	(0.0290)	(0.0285)	(0.0285)		(0.0289)
female						0.161	0.157	0.148	0.160		0.140
						(0.182)	(0.182)	(0.184)	(0.182)		(0.185)
duration						-0.000139	-0.000217	-0.000189	-0.000116		-0.000280
						(0.00119)	(0.00119)	(0.00119)	(0.00119)		(0.00120)
Singapore						0.0945	0.0908	0.0891	0.102		0.0803
						(0.246)	(0.242)	(0.244)	(0.243)		(0.246)
Constant	0.991	-1.034	-1.426	-0.942	-1.102	-1.001	-1.346	-0.902	-1.104	-1.347	-1.291
	(0.965)	(1.657)	(1.635)	(1.663)	(1.676)	(1.768)	(1.730)	(1.777)	(1.782)	(1.723)	(1.840)
Observations	205	205	205	205	205	205	205	205	205	205	205
Pseudo R^2	0.00365	0.0130	0.0215	0.0138	0.0128	0.0188	0.0278	0.0193	0.0188	0.0237	0.0297

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 27: Positive Confabulation: Question 4

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	2.169**	2.134**	2.212**	2.179**	2.179**	1.951*	2.019*	2.114**	2.070*	2.182**	2.078**
	(1.041)	(1.050)	(1.033)	(1.055)	(1.061)	(1.042)	(1.038)	(1.057)	(1.058)	(1.062)	(1.054)
δ		0.112	0.135	0.187	0.185	0.655	0.695	0.805	0.729	0.0928	0.745
		(1.255)	(1.254)	(1.257)	(1.255)	(1.238)	(1.245)	(1.243)	(1.241)	(1.257)	(1.242)
paf		0.203				0.257				0.200	0.272
		(0.185)				(0.190)				(0.187)	(0.193)
naf			-0.174				-0.0957			-0.172	-0.0981
			(0.180)				(0.185)			(0.184)	(0.188)
pur				0.00620				0.133		0.0625	0.205
				(0.159)				(0.165)		(0.210)	(0.215)
nur					0.00478				0.0701	-0.0506	-0.0710
					(0.162)				(0.168)	(0.212)	(0.217)
ra						-0.0327	-0.0232	-0.0284	-0.0270		-0.0351
						(0.0345)	(0.0335)	(0.0336)	(0.0339)		(0.0346)
aa						-0.0311	-0.0329	-0.0319	-0.0321		-0.0311
						(0.0251)	(0.0248)	(0.0249)	(0.0248)		(0.0252)
female						0.184	0.194	0.205	0.203		0.184
						(0.162)	(0.162)	(0.162)	(0.162)		(0.163)
duration						0.00186*	0.00183*	0.00191*	0.00187*		0.00195*
						(0.00105)	(0.00103)	(0.00104)	(0.00104)		(0.00107)
Singapore						0.823***	0.797***	0.836***	0.813***		0.853***
						(0.224)	(0.223)	(0.225)	(0.222)		(0.229)
Constant	-2.047**	-2.479	-2.000	-2.246	-2.241	-3.772**	-3.327*	-3.869**	-3.648**	-2.298	-4.102**
	(1.012)	(1.622)	(1.634)	(1.680)	(1.671)	(1.742)	(1.746)	(1.789)	(1.767)	(1.717)	(1.842)
Observations	259	259	259	259	259	259	259	259	259	259	259
Pseudo R^2	0.0137	0.0171	0.0164	0.0138	0.0138	0.0715	0.0674	0.0684	0.0671	0.0197	0.0747

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 28: Positive Confabulation: Overall

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
β	1.477**	1.554**	1.544**	1.478**	1.511**	1.318**	1.307**	1.284**	1.297**	1.495**	1.282**
	(0.631)	(0.633)	(0.634)	(0.634)	(0.637)	(0.639)	(0.639)	(0.639)	(0.643)	(0.637)	(0.643)
δ		1.255*	1.240*	1.197	1.230*	1.663**	1.683**	1.625**	1.657**	1.221	1.640**
		(0.748)	(0.745)	(0.746)	(0.745)	(0.740)	(0.739)	(0.740)	(0.740)	(0.749)	(0.740)
paf		-0.0442				0.00754				-0.0471	0.00952
		(0.119)				(0.121)				(0.120)	(0.122)
naf			0.0321				0.0710			0.0474	0.0837
			(0.113)				(0.114)			(0.115)	(0.116)
pur				-0.156				-0.0951		-0.195	-0.124
				(0.100)				(0.102)		(0.125)	(0.128)
nur					-0.0622				-0.0358	0.0592	0.0414
					(0.104)				(0.106)	(0.130)	(0.132)
ra						-0.0369*	-0.0375*	-0.0355	-0.0358		-0.0373*
						(0.0223)	(0.0220)	(0.0221)	(0.0222)		(0.0225)
aa						-0.0165	-0.0168	-0.0169	-0.0167		-0.0171
						(0.0161)	(0.0161)	(0.0161)	(0.0161)		(0.0162)
female						0.217**	0.219**	0.208**	0.215**		0.210**
						(0.102)	(0.102)	(0.103)	(0.102)		(0.103)
duration						0.000408	0.000400	0.000363	0.000392		0.000359
						(0.000638)	(0.000636)	(0.000637)	(0.000638)		(0.000639)
Singapore						0.418***	0.419***	0.402***	0.415***		0.403***
						(0.137)	(0.136)	(0.137)	(0.136)		(0.138)
Constant	-1.508**	-2.699***	-2.794***	-2.411**	-2.611***	-3.199***	-3.280***	-2.953***	-3.100***	-2.465**	-3.101***
	(0.614)	(0.992)	(0.991)	(1.003)	(1.014)	(1.028)	(1.022)	(1.036)	(1.045)	(1.038)	(1.077)
Observations	636	636	636	636	636	636	636	636	636	636	636
Pseudo R^2	0.00665	0.00999	0.00993	0.0126	0.0102	0.0343	0.0347	0.0353	0.0344	0.0132	0.0359

Note: Robust standard errors in parentheses, *** $p<0.01$, **$p<0.05$, * $p<0.1$