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ORIGINAL ARTICLE

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"Just forget it." Memory distortions as bounded rationality

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Abstract Distortions in memory impose important bounds on rationality but have been largely disregarded in economics. While it is possible to learn, it is more difficult, and sometimes impossible, to unlearn. This retention effect lowers individual utility directly or via reduced productivity, and adds costs to principal-agent relationships. The engraving effect states that the more one tries to forget a piece of information the more vivid it stays in memory, leading to a paradoxical outcome. The effects are based on, and are supported by, psychological experiments, and it is shown that they are relevant in many economic situations and beyond.

Keywords Memory · Bounded rationality · Learning · Retention · Ironic process theory · Principal–agency theory

1 Asymmetric memory control

Individuals have only imperfect control over their memory. They are not able to *learn* everything that they would like to know. But it is possible to integrate new knowledge into one's memory by applying sufficient effort, time and resources.

Interestingly enough, in some important circumstances, *forgetting* or removing information from one's memory, is difficult to achieve and

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sometimes even impossible. While there are mental strategies helping us to forget,[1] in many cases it cannot be achieved at all. It is, for example, impossible to forget the information that an object one has bought, believing that it is an original work of art (say a Picasso painting), is in fact a fake. One would be better off not knowing that it is a fake, but one cannot choose to forget such utility reducing information. This "*retention effect*" suggests that there is a fundamental asymmetry between learning and unlearning.

Moreover, making an effort to get rid of a piece of information stored in our memory tends to have a *counterproductive* effect: it is rendered more vivid and therewith is stored more effectively in our memory. The advice by well–meaning friends to forget that one has acted like a fool in the past tends to make the occurrence more, and not less, salient in our memory. This "*engraving effect*" produces higher transaction costs in principal–agent relationships. Parents who constantly advise their children not to drink alcohol, to take drugs or to engage in sex, often make it more difficult for the children not to think of it. An important case involves judges who, following the rule of admissible evidence, must instruct the jury to ignore particular evidence. But such orders tend to make the evidence more, rather than less, salient in the jury members' memory. Once jurors know certain information, they find it difficult, if not impossible, to refrain from giving it further consideration. Caspar et al. (1988; see also Edwards and Bryan 1997) presented mock jurors with a case in which police officers entered a person's flat without a warrant and injured the occupant. Some jurors were given the information that the police found contraband in the flat. Despite the fact that the jurors were instructed that this information should not be taken into account when deciding about the damages the occupant of the flat should be awarded by way of compensation for his injuries, the jurors awarded significantly lower settlement when the contraband was mentioned than when it was not mentioned. Instructions to ignore the contraband proved to be ineffective; the jurors were unable to forget this piece of evidence.

The restrictions on unlearning lead to an overrepresentation in memory of undesired information. It reduces individual utility directly or indirectly by affecting behavior. It distorts resource allocation and produces economic costs which otherwise would be absent. The difficulty in forgetting is also of direct relevance in many economic activities. An example is one company being taken over by another company. In the case of such mergers, the employees of the company taken over tend to cling to the routines they learned in the old company. They find it difficult, if not impossible, to forget how things were done there. The high cost of merging the "cultures" of firms, and often the failure to achieve it, is consistent with the retention effect.

[1] For instance, distracting oneself by going on vacation or changing one's work place or place of living. See more fully Golding and MacLeod (1998). For more general applications to history and politics, see e.g., Weinreich (2000), Rothstein (2000) and Horne and Levi (2002). Most psychological theories of memory assume that there is no real erasing of memory. An adequate metapher is a library in which no book is lost but individuals no longer know where it is located. If one had the correct location signature one would be able to find the book again. In social psychology this process is known as "cognitive accessability". See e.g., Higgins (1989).

Non-forgetting also plays a role at the macro–economic level. Thus, for example, in the 1930's the German population was unable to forget the hyperinflation of the 1920's, though the economic situation changed dramatically and the great Depression set in. The German government then pursued a deflationary policy by running a budget surplus when an expansionary policy would have been more appropriate.

This paper focuses on the distortions caused by the cost of unlearning or non-forgetting. This, of course, does not mean that learning is unimportant or that it is always impossible to forget. Much of what we think and do is indeed forgotten. Neither is it argued that the impossibility to forget may, in certain situations, help people to behave rationally in the long run.[2] In that sense, the failure to forget may in some respects be evolutionarily advantageous. While these aspects may be important, they are neglected here in order to concentrate on those cases where non-forgetting is an instance of bounded rationality.

The argument developed is based on two fundamental assumptions:

1. Some pieces of information stored in the memory are difficult, and others are even impossible, to forget;
2. Individuals have limited control over forgetting.

Consequently, the retention and the engraving effects are major limitations on individual human rationality important for economics and beyond. Section 2 links these ideas to related literature in economics. Section 3 discusses the retention effect, relates it to insights gained in social psychology and demonstrates its importance for economic and social behavior. Section 4 does the same for the engraving effect. The following Section 5 identifies the costs produced by the two kinds of memory distortions. Section 6 concludes.

The reader should be warned that this paper should be considered a first, and necessarily incomplete, attempt to analyze the economic consequences of having incomplete control over forgetting. Wherever possible, the arguments are bolstered by empirical evidence. But in many cases there is, to my knowledge, no such evidence available. This paper may therefore also serve as an incentive to provide empirical evidence preferably not only by laboratory experiments but also field data.

2 Related literature

Economists have long been aware that individuals are not fully but only boundedly rational (Simon 1957, 1982; Selten and Tietz 1980). One can go even further: "Individuals make systematic errors that make them worse off" (Babcock and Loewenstein 1997, p. 116). Distortion of judgment caused by imperfect retrievals from memory, among others the endowment and the sunk cost effects, and in particular, the hindsight bias, have been extensively studied in the literature on behavioral anomalies (e.g., Haskie and Dawes

[2] When individuals are driven to act according to their short run, instead of their long run, interests they may be helped by the impossibility of forgetting.

2001, and Frey and Eichenberger 1994). That individuals make systematic (rather than purely random) errors is inconsistent with standard neoclassical economic theory which is based on the assumption that individuals maximize their own utility (subject to constraints). As a consequence, revealed preference allows us to deduce the underlying preferences from observed behavior. This relationship is no longer valid once it is acknowledged that individuals make systematic mistakes (see, in the context of happiness research, Frey and Stutzer 2004).

Memory distortions have been an important topic in psychology for a long time; a recent prominent example is Kahneman (Kahneman 1999, 2000). In contrast, only a few economists have worked on this topic. A major exception is Mullainanthan (2000; see also Dow 1991), who looks at the effects of learning on human behavior. He distinguishes between "rehearsal" and "associativeness" as determinants, and identifies the conditions under which the beliefs thus generated lead, on average, to over–reaction and under–reactions. In an elaborate theoretical model, he is able to show that individual consumption behavior differs from the predictions made on the basis of the standard neoclassical model. However, he provides only a few real life applications and does not test his hypotheses empirically. His approach and my approach share the view that "memory limitations might be an important component for realistic models attempting a unified treatment of bounded rationality" (Mullainanthan 2000, p. 31).

The "curse of knowledge" suggests that better informed agents are unable to ignore private information even when it is in their own interests to do so. Thus, having more information is not always better. Camerer et al. (1989) accordingly develop the concept of a "utility decreasing stock of information", which is closely related to the memory distortion developed here. Regret theory (Loomes and Sugden 1982; Bell 1982) also looks at a situation where individuals suffer a utility loss because they compare with what they could have gained. They would be better off not to compare the choice they made with other alternatives. Cognitive dissonance theory (see Festinger 1957) suggests that people are aware that they suffer a utility loss when they receive particular information after having made a choice, and therefore shield themselves from such information. Akerlof and Dickens (1982; see also Gilad et al. 1987) show that such an effort can have important behavioral consequences.

Some economics scholars have observed that it may be counterproductive, or at least futile, to try to actively remedy an unfortunate situation. Thus, O'Donoghue and Rabin (1999, p. 119) argue for the case of insufficient will–power, that "in many situations, being aware of self–control problems can exacerbate self-control problems". It has also been shown that a conscious effort to achieve happiness tends to backfire, as empirically shown by Schooler et al. (2001).

The retention and engraving effects are based on the observation that individuals are only incompletely able to control the kind and extent of forgetting. The process of unlearning is to some extent exogenous. A recent literature in economics deals with *memory manipulation*, i.e., looks at memory as something which can be influenced. Carillo and Mariotti (2000) formalize a particular aspect of such endogenization of memory, the ex ante cost of

memory manipulation via the choice of information structure. Pathbreaking and most fascinating work on endogenizing memory is due to Bénabou and Tirole (2004), where memory manipulation tends to be ex ante costly for individuals with low time inconsistency, but beneficial for those persons with substantial time inconsistency. Following Bénabou and Tirole (2004), memory manipulation may lead to compulsiveness. Kopczuk and Slemrod (2004) study the consequences of denial of death, a widespread and surprising phenomenon in view of the fact that the only certain thing in life is eventual death. Dessi (2003) explicitly deals with "collective memory", but unlike many philosophers and sociologists does so on the basis of individual choice.

3 The retention effect

The *retention effect* states that, under certain conditions, individuals retain useless or damaging information in their memory. They are unable to get rid of such information, much though they would like to. As a result, the corresponding (undesired) information is over-represented in the memory and provokes systematically distorted decisions and biased behavior. The distortions manifest themselves in three ways:

1. The *utility* of a person subject to the retention effect is *directly* reduced. This is like the example already mentioned of being informed that one does not own a real Picasso painting but a fake. The person, who bought the painting for their own pleasure, experiences extreme disappointment and would certainly be better off not knowing that the painting is an imitation. But the person finds it impossible to forget the information stored in their memory.[3]
2. *Utility* is *indirectly* reduced due to overrepresentation, leading to distortions in behavior and resource allocation. An example is a poor person who makes a fortune but cannot forget his miserable past, much though he would like to. The person has not adjusted his or her "cultural capital" to the new position achieved. As a consequence, his consumption behavior is that of a "nouveau riche", though he would love not to appear as such.[4] Another case is a principal who finds it more costly to make his agents behave in his best interests because the agents' memory is marred by incompatible information. A good example is that of the employees of a company taken over by another company, who find it impossible to forget the previous routines. This tends to make them unfit to follow the routines appropriate in the new company. Such failure to unlearn makes a

[3] The point is *not* that the painting has a reduced monetary value and can only be sold at a lower price. The monetary loss is obvious and does not constitute any anomaly. The example refers to the direct *utility* loss due to knowing that the painting is a fake. That such a utility loss occurs is one of the "classical" paradoxes in the economics of art (see e.g., Throsby 2001; Towse 1997; Blaug 2001; Frey and Pommerehne 1989; Frey 2000).

[4] The general phenomenon of "underconsumption" and "overconsumption" has been analyzed by Ameriks et al. (2003), and also by Loewenstein and O'Donoghue (2004).

merger more costly than it would otherwise be. It may even lead to total failure, with large economic costs.

3. The retention effect has been studied in psychology in the general context of "thought suppression" (Wegner 1998, and Wenzlaff and Wegner 2000, provide an extensive survey, including much experimental evidence; see also Beevers et al. 1999) and, somewhat more specifically, of "intentional forgetting" (see for instance Golding and MacLoed 1998).[5] This paper intends to study the importance of the retention effect for the economy and society, by discussing specific real life observations consistent with it. Most of these applications are obvious so that they only need to be mentioned briefly.

Not being able to forget an event *directly reducing utility* is a common phenomenon, which probably most readers have experienced for themselves.

A typical situation is when one has *unwillingly* violated *social customs and norms* and has embarrassed oneself. An example would be to put in an appearance at a small dinner party because one thinks one has been invited, but in actual fact was not. Another example would be telling the same story more than once to the same person. Most, but not all, people feel extremely embarrassed by such events and would be happy to forget their unfortunate behavior, but (at least for some time) retain it in their memory.

Another typical situation has to do with *traumatic experiences* occurring in one's past. In the economic sphere, examples are poverty or wealth in one's youth affecting present consumption behavior in the sense of overspending, like with the "nouveau riche". Other people may respond in the opposite way, namely by acting like misers. But both reactions are undesired by the people in question; they would prefer to be able to shed their childhood experiences and consume in a way appropriate to the new status. Another instance is that of parents who have an alcohol problem. This may induce their children to abstain completely, even though they might like to enjoy a good glass of wine. The effect of physical violence or feeling a failure at school may influence behavior as a grown–up against one's will. Some children who have attended a strict religious school cannot get rid of this memory and later violently rebel against the respective church, though they are well aware that it is against their own interests. The same holds for sexual violations (see the evidence in Kuyken and Brewin 1995, and, in a somewhat different context, in Johnston et al. 1997). As has already been mentioned, experiencing Hyperinflation and Depression often affect people's consumption and work behavior for a long time, though they would be better off without that memory. It has been empirically shown that spells of unemployment "scar" people for an extended period of time afterwards and make it more difficult for them to find a new job (see Clark et al. 2001). Other traumatic experiences from the past which may strongly influence present consumption and work behavior in an undesirable

[5] The state of psychological research on memory is presented by, for example, Spear and Riccio (1994), Schacter (1996, 2001) and Schacter and Scarry (2000). This paper uses the concept of memory in a broad way. Future work on the economic consequences of the limited control of unlearning may find it useful to distinguish between memory and conscious awareness (see, more fully, Wegner 1998).

way by the persons concerned are experiencing wars or captivity. Some persons, for instance, who were detained in a German concentration camp, simply *cannot* bring themselves to buy a German car, even if they would like to.

Yet another set of instances of direct utility decreasing retention is getting the information that you have *just missed* an opportunity. Persons who narrowly missed catching a train or plane, or winning the jackpot in a lottery, would be better off to be able to forget such information, but in many cases cannot.

A final set of cases in which the retention effect directly affects utility occurs when information decreases the intrinsic value of a person or an object. Many husbands would prefer not to know that the child they rear with their wife has been fathered by another man. But once they know, they cannot forget and often become unhappy, which sometimes results in the breakdown of the marriage. Similarly, many if not most people would prefer not to learn that they have contracted an illness for which there is no cure. Many people would feel better off not having this information but, once they know, they are totally unable to forget.

Other retention effects impair a person's *productivity* and therefore indirectly lower a person's utility.[6]

One example is having misleading or wrong information stored in one's memory, without which one would be able to act in a more productive way. Capital markets provide an illustration: in order to invest successfully, information relating to the past is best forgotten – at least if one accepts that these markets are dominated by random walks. But most persons find it impossible to disregard past experiences when they make investment decisions. For instance, they believe that if the price of a stock has fallen by a certain percentage compared to the past, its value *must* rise again.

A second example in which the retention effect lowers individual productivity occurs when people stick to ideas or rules which have outlived their usefulness.[7] Take the case of scholars committed to old theories, when there are superior new ones. It has sometimes even been argued that new theories can only be introduced by new generations of scholars. Some economists would consider the introduction of Keynesianism after the War, and later New Classical Macroeconomics, to be cases in point (but that is controversial). The argument is that scholars would like to get rid of old ideas but are unable to do so.[8] Similarly, the suppression of stereotypes is difficult to achieve, as has been experimentally shown by Monteith et al. (1998) and Monteith et al. (1998).

[6] The importance of learning and forgetting for productivity is discussed for example for aircraft production by Benkard (2000), for ship production by Argote et al. (1990), and for services by Darr et al. (1995).

[7] This is similar to Mullainanthan's (2000) rehearsal effect.

[8] There is an alternative explanation of the resistance of older scholars to adopt new theories: they have accumulated intellectual capital in the old ideas and are therefore relatively more competitive in using and amending them than are younger scholars. They do not have this comparative advantage with new theories and are therefore reluctant to take them up, and sometimes fight them.

Another example of productivity decreasing retention refers to discrimination. People often judge minorities by resorting to "statistical discrimination", whereby its individual members are evaluated according to the average performance of the minority instead of according to the particular person's productivity. Thus, for example, female researchers get fewer and smaller grants, even when they have more and better publications than male researchers.[9] Another example is that (both male and female) airplane passengers used to prefer male pilots. Such discrimination is consistent with the retention effect. People are unable to get rid of the average information concerning particular minorities stored in their memory and are therefore incapable of judging a particular person according to his or her individual merits. Such statistical discrimination is of considerable importance, especially on the labor market.

There are also many instances where the retention effect *adds to the cost of principal–agent relationships*.

Older employees often find it difficult, or even impossible, to adopt new rules, routines and techniques, because they are unable to eliminate the old ones from their memory, even if they are more than willing to do so. One of the consequences is that they are forced to retire earlier than they wish, though their physical productivity is as high as ever. The high cost of mergers may also be attributed to a similar retention effect.

4 The engraving effect

The *engraving effect* states that a person's attempt to dispose of information in their memory makes such information more vivid and therefore accentuates the retention effect. The effort to forget is counterproductive as it leads to the opposite of what one is trying to achieve. The engraving effect involves two types of cost: the counterproductive effect itself, which strengthens the retention effect, and the resources in terms of time, effort and involvement of other persons used in the attempt to forget.

This paradoxical effect has been analyzed in psychology as "ironic process theory" (Wegner 1989, 1994, 1997, 1998; Wegner and Wenzlaff 1996). The so-called "white bear" experiment[10] (Wegner et al. 1987) shows that suppressed thoughts may occupy a more important place than before any attempt was made at suppression. As ironic process theory is part of the experimental psychology of memory and thinking, the consequences on behavior in actual life situations have received small thrift.

[9] I owe this example to Margit Osterloh.

[10] If thought suppression worked perfectly, no unwanted thoughts would remain in the memory at all. The experiment assumes that college students in Texas would almost never think of a white bear spontaneously. The evidence shows, however, that such a thought regularly rebounded during or after suppression. This is an indication that suppression was not successful. Further experiments are summarized by Wenzlaff and Wegner (2000, pp. 61–64, 67–68). The post–suppression rebound effect has been replicated many times – recently, for instance, by Kelly and Kahn (1994), Lavy and van den Hout (1994), McNally and Ricciardi (1996), and Harvey and Briant (1998).

The engraving effect is more general than the retention effect because the latter refers to particular events which individuals find difficult or impossible to forget. The engraving effect, in contrast, is produced by the effort to forget which may be the case for all possible events. The engraving effect can moreover be considered a specific instance of a broader phenomenon, namely the *affermative consequences of negation*. Dealing with the information that something is *not* the case generates cognitive structures favoring affirmation and, under particular conditions, leads to corresponding evaluations. In the case of the engraving effect, the specification of the intention to forget activates those issues which one tries to de-activate.[11]

There are many relevant real life instances reflecting the effect of engraving.

Utility is directly reduced when persons resort to "ruminations" about earlier decisions. Such activity strengthens retention and reduces welfare, but the persons concerned are unable to stop thinking back. Much experimental evidence also suggests that persons with eating disorders, who try to suppress these cravings, end up thinking even more about them. As a consequence, they are less able to solve their eating problems, making them increasingly miserable (see Herman and Polivy 1993). Similar counterproductive effects may occur with persons subject to deviant sexual thoughts, for instance child molesters (Johnston et al. 1997; Johnston et al. 1997).

More generally, research on happiness (see Frey and Stutzer 2002, 2003) suggests that persons aspiring to raise their happiness are less able to do so than are persons who do not think about it, but just get on with their lives (the empirical evidence is provided by Schooler et al. 2001). Individuals focusing on how they could make themselves happier store the existing gap vividly in their memory, which is consistent with the engraving effect.

Engraving in one's memory is particularly strong when it is induced from outside, i.e., in a *principal-agent setting* . An important case has been mentioned in the introduction, namely judges instructing jurors to disregard particular evidence. But getting such an instruction in actual fact served to reinforce such evidence in jurors' memories. Another case occurs when teachers warn their pupils not to cheat in exams. These admonitions make cheating more salient in pupils' memory, possibly leading to a counterproductive result. More important for economics are warnings provided by tax authorities not to cheat. Such statements suggest to taxpayers that cheating is a real possibility. Another interpretation is also possible. The admonitions may signal to the addressees that cheating is widely practiced. Cheating becomes considered a less serious violation of norms "because everybody does it", and the perceived probability of being detected falls. As a result, cheating tends to increase. Preliminary evidence for taxpaying in Switzerland is consistent with a counterproductive effect due to engraving (see Feld and Frey 2002 et al. 2002).

[11] I owe this generalization to Fritz Strack (personal communication). See Strack and Deutsch (2004), and Mussweiler and Strack (2001).

The discussion and the empirical evidence cited suggest that the retention and the engraving effects occur in many parts of the economy and beyond. Such distortions of memory should not be neglected by economic theory. The next section analyzes the determinants of the size of the cost induced by the two effects.

5 The costs of memory distortion

There are four major variables determining the cost of not forgetting. The retention and the engraving effects may be hypothesized to have more influence on individual behavior, and more influence on raising the costs:

1. The more *vividly* the information is stored in memory. Psychological research suggests that emotional information is more difficult to suppress than neutral information (see, e.g., Davies and Clark 1998) and when it is presented in a graphic and upsetting setting rather than in a sterile setting (see Edwards and Bryan 1997). In the context of research on happiness, it has been found that the highest intensity of a (negative) experience is remembered but not lower doses (see Kahneman 1999, 2000);
2. the *less time* has elapsed since a piece of information entered the memory. Forgetting takes a hyperbolic form. Recently assimilated information is more likely to be forgotten than information acquired in the past; this is known as Jost's Law (Loewenstein and Elster 1992; Rachlin and Raineri 1992). It has also been empirically established that the end point of a (negative) experience matters while the actual duration is neglected (see Kahneman 1999, 2000);
3. the *more dynamic the environment* is. Not being able to forget produces higher costs for individuals who live in societies or have occupations subject to rapid change rather than those living in more stable environments. Spatially and socially mobile persons also suffer higher costs from not being able to forget;
4. the *more important the piece of information* is. The retention and engraving effects produce substantial costs when the information concerned is crucial for one's life, job, investment or consumption. In contrast, it matters little if an individual conserves unimportant or totally irrelevant information in his or her memory.[12] This view is somewhat counterintuitive as it is often said that one should forget unimportant, and remember important, information. This is true only if the important information is at the same time useful information. Individuals benefit if they can shed information which was important in the past but which has outlived its usefulness.

[12] Except perhaps if the memory is "overloaded", but this does not seem to be a serious restriction.

6 Conclusions

Distortions of memory due to the problem of unlearning useless information are of considerable importance in many economic and social situations. Some information is virtually impossible, while other information is difficult, to forget. This retention effect imposes costs on individuals by reducing their utility and productivity, and makes principal–agent relationships less effective.

The engraving effect designates an even more powerful distortion of memory and leads to counterproductive outcomes. The effort to dispose of pieces of useless information stored in memory makes it even harder to unlearn it and consumes resources.

This paper seeks to outline the importance of limited control over unlearning for economics. Much further theoretical and empirical work is needed to analyze more precisely under what conditions, and to what extent, the retention and engraving effects apply. Future research may also endeavor to isolate self-binding rules helping people to avoid the errors due to the insufficient control over unlearning. An example are couples who agree not to inform each other about occasional infidelities knowing that they would overreact to such information and would destroy an otherwise well–functioning and highly valued relationship. Similar self–binding rules may possibly be found with actors on financial markets. Reactions and countermeasures to the retention and engraving effects may also be found at the societal level in the form of collective institutions (such as analyzed in Frey and Eichenberger 1994 for the case of behavioral anomalies).

This paper has achieved its goal if the attention of scholars has been drawn to how important the systematically limited control over forgetting is for the economy and society.

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