How fast memory decreases for tasks

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Abstract

"How fast memory decreases for tasks" by Vasco Vasconcelos

The main aim of this thesis was to find how fast memory decreases for tasks that people need to do. In order to do that an online survey was conducted where participants were asked to write five tasks they needed to do in the next seven days, then they were asked to wait for a while and finally rewrite those tasks. The results showed that there are two significant decreases in memory performance. First there is a significant decrease between a 10-minute delay period and one hour and the other is between a one hour and 24-hour delay period. The second aim of this thesis was to test some of the results found in previous works. Results show that there seems to exist a primacy effect, however no evidences of a recency effect was found, no evidence that gender affects memory prediction and performance plus, results were negative for an overestimate of participants' prediction regarding their memory performance. Results contradict previous works since the methodology used in studies on the field of memory are usually done in a laboratory, they usually require participants to learn new things to later be remembered and finally, the tasks and things participants are requested to do are usually abstract or irrelevant for their lives. This study has none of those features thus the results are not as one would predict.

Acknowledgements (Preface)

To my parents for always providing me with the best tools for succeed and to my thesis supervisor for his help through this thesis.

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Introduction

The main aim of this study is to understand how fast retrospective memory (which refers to remember things) decreases for everyday tasks.

Being able to remember which tasks we have to do in the future is essential for our daily lives and is something most people take for granted. However, we do not always remember to do a task that we had previously planed, like buying a birthday present or pay the bills on time for example.

Another important part of our memory is prospective memory, which allow us to remember the things we need to do at the right time (Judi Ellis and Kvavilashvili 2000). By understanding how fast our retrospective memory decreases for tasks, we hope to help people to take actions to prevent them from forgetting what they need to do in the future and introduce mechanisms to improve their memory performance. A better explanation of the differences in retrospective and prospective memory will be given later in this thesis.

It is important to notice that in this study we did not attested if participants indeed carried out their tasks. We only tested if they remembered the tasks they said they needed to do. In fact, a participant who had a perfect score (meaning that their memory performance did not decrease) could had forgotten to do the things they stated that needed to be done.

In order to test how fast memory decreases for tasks, participants were asked to write five tasks they had to do in the following seven days, then we asked them to wait for a certain amount of time and finally we requested them to write those tasks again. It is expected to observe a decrease in memory performance as subjects are asked to wait for higher delay times but the rate at which it decreases is expected to be higher at the beginning (in the first delay time intervals) but slower toward the end, as many studies previously showed (Wixted and Ebbesen 1997; Ebbinghaus 1913). Therefore, four delay time intervals were chosen within a one hour delay time interval while only one delay time interval was higher than 60 minutes.

Apart from this, we decided to test if some of the findings in the memory field were true in this experiment. Namely we wanted to test if:

- There is a primacy and recency effect as shown in Ebbinghaus experiments (Ebbinghaus 1913), meaning that people tend to remember better their first and last tasks (Bower 2000);
- If gender affects memory performance and prediction since some studies showed that women perform better than men (Ceci and Bronfenbrenner 1985; Kurtz-Costes, Schneider, and Rupp 1995; Huppert, Johnson, and Nickson 2000);
- And if people's overestimate their performance (Fernandes 2013).

The main reason for testing other authors work has to do with the different methodology used in this study compared with the traditional methodology used. First, in the field of memory most researches are conducted in a laboratory and use a wide range of tasks to simulate how our memory works in the the real world (Bower 2000). Second, most of the studies conducted so far on how fast memory decreases are focus on newly acquired knowledge instead of tasks that we already are aware that we need to do in the future. Third, the tasks given to participants are usually very abstracts and have no real application in the real world. One of the most popular tasks is to remember some words and identify them later, or remember to press a key when a certain letter appears for example.

This thesis however distances itself for those three reasons, it is conducted on the real world instead of a laboratory, participants were not asked to remember new things to later be remembered (therefore there was no manipulation in the encoding process which is also a bonus and will be explained later why), and finally, participants were asked to remember real tasks they have to do on their daily lives instead of abstract and irrelevant tasks for their lives. The idea was to simulate a study in a way that reproduces how people use their memory in their daily lives and to get an higher "ecological validity", as some authors have been arguing that this is the best method to look at the science behind memory (Neisser 1978).

As it will be shown in this thesis, nowadays we know that our memory works in very different ways for many different situations, thus there is no universal system that can explain how our brain storages and processes information to be used later. Therefore, by doing this experiment we might not fully understand the reasons behind the results we get either from the decrease in retrospective memory performance or from the other three hypotheses resulted from previous works. Nevertheless, we will be able to get a broader view of how previous work performs in real life situation, which can empower the work of previous authors or cast some doubts on their endeavours.

I would like to point out that even though this might seem a study that has very few to do with my Master in Management with Specialization in Strategic Marketing, this study was proposed to me by my thesis supervisor and my former teacher of Consumer Behaviour at Católica who studies the field of memory. Therefore, I believe we can get valuable information regarding consumer behaviour, which can be used for marketing endeavours (like when a purchase requires someone to perform a task before hand) and what are some of the mistakes to avoid when encoding or retrieving a task from consumers' minds.

Review of relevant literature

Memory field started being studied at least 2,000 years ago by Aristotle in his dissertation "On the Soul" (Aristotle 1990). However, it was Hermann Ebbinghaus who at the end of the XIX century pioneered the experimental study of memory (Ebbinghaus 1913; Bower 2000). Since then many theories have risen trying to explain how memory works. In this thesis however, only a few of the most direct (meaning more relatable to the study in hands) and relevant findings in the field of memory will be used in order to try to explain the results from the experiment.

Retrospective vs Prospective memory

For the sake of this thesis one must know these two basic concepts: retrospective memory and prospective memory.

Retrospective memory refers to the things we remember. To be more specific, in the literature about memory it is specified that it refers to the memory of people, words and events encountered or experienced in the past (G. Einstein, McDaniel, and Brandimonte 1996). Prospective memory on the other hand is a form of memory that involves remembering to perform a planned action or recall a planned intention at some future point in time (G. Einstein, McDaniel, and Brandimonte 1996).

For example, lets imagine someone schedules a doctor appointment at 6pm after work. When that person is leaving work in order for him to go to the doctor appointment both retrospective and prospective memory must be present. When leaving work that person has to remember to go to the hospital (prospective memory) and after that him/she has to know that he/she went to the hospital for a doctor appointment (retrospective memory). Lets supposed that the person remembered to go to the hospital (prospective memory worked) but was not sure what he/she had to do (retrospective memory failed), he/she could go do a check-up, withdraw analysis, schedule an appointment and so on.

This thesis focus on retrospective memory, meaning it is not interested in knowing if participants conducted their intention until the end or even if they remembered that there was a task that needed to be done. Instead, it is interested in knowing if they remembered their intentions, if they specifically remembered which tasks they said they had to do. Signs of prospective memory failure in the study conducted for this thesis can only be observed on the participants who reached the second part of the survey that required them to wait for a specific time. However even for those participants it is not possible to measure their prospective memory since unfilled answers after this point might result in participants' willingness to quit the survey and not on a prospective memory failure.

Event-base tasks vs time base tasks

When people want to remember something, usually there is an intention behind that pushes their brains to activate that memory (Hicks, Marsh, and Cook 2005). Although there are many types of intentions, event-based and time-based intentions have proven to be the best to be controlled in laboratory experiments (Hicks, Marsh, and Cook 2005). Therefore, most studies use one or both of these types of intentions (Taylor et al. 2004; Hicks, Marsh, and Cook 2005). Regarding specifically how memory works for tasks, there has not been done much research done so far.

So, when there is a task we intend to perform later in the future, generally speaking there are two ways in which that intention comes to our mind. It either comes as a time-based intention or as an event-base intention (Hicks, Marsh, and Cook 2005; Kliegel et al. 2001). Time-based intentions have been claimed to require more self-initiated processing than event-based tasks and thus more will power (Gilles O. Einstein et al. 1995; Taylor et al. 2004; Hicks, Marsh, and

Cook 2005). For reasons that are not entirely clear, the vast majority of research has investigated event-based prospective memory whereas only a handful of articles have appeared on time-based prospective memory (Taylor et al. 2004; Hicks, Marsh, and Cook 2005).

A time-based intention refers to when one must complete a task after a certain period of time (G O Einstein and McDaniel 1990; Gilles O. Einstein et al. 1995; Park et al. 1997), such as remembering to perform an action after 10 minutes, like it was asked to some of the participants in the experiment of this thesis. Within time-based tasks there is a distinction between those that must be completed at an exact point in time (called pulse intentions) versus those that can be completed within a window of time (Hicks, Marsh, and Cook 2005).

An event-base intention refers to when a person is doing an ongoing activity (such as watching a movie, reading a paper, answering questions and so on) and it has to search for the environment for an intention-related cue that activates its memory and compels him to complete his previous intended activity (Brunfaut, Vanoverberghe, and D'Ydewalle 2000; Gilles O. Einstein et al. 1992; J Ellis, Kvavilashvili, and Milne 1999; Maylor 1996; Maylor 1998; M a McDaniel, Robinson-Riegler, and Einstein 1998). For example, imagine I have to return a book to a friend at school. According to the event-base theory, while I was absorbed in my daily routine (attending classes, hanging-out with friends and so on), I would be at the same time monitoring the environment for a cue that would activate my brain to remember that I have to return the book to my friend. That cue could be anything that would activate my intention to deliver the book, however, the most obvious cue would probably be seeing the friend that I have to deliver the book to.

For event base tasks, it has been discussed whether the process of detecting the cue in the environment is automatic or if it needs to have a monitoring process that requires the allocation of cognitive resources (Smith 2003; Mark a McDaniel et al. 2004). According to the multi-process view theory, cue detection will be automatic when one or more of the following conditions are met: when the cue and the to-be-performed target action are highly associated, when the cue is salient, and when the ongoing processing focuses attention on the relevant features of the cue (Mark a McDaniel and Einstein 2000; Mark a McDaniel et al. 2004). Otherwise, cue detection can require significant processing resources. By contrast, the preparatory attention and memory model argues that even under those conditions where according to the multiprocess view theory cue detection should be automatic, having an intention creates a processing cost manifested in the ongoing activity itself (Smith 2003; Smith and Bayen 2004). More specifically one of the papers found that lexical decisions as an ongoing task were slowed when participants possessed an event-based intention relative to not having an intention (Smith 2003). PAM theory argues that fulfilling event-based intentions always requires significant and measurable capacity.

In the experiment conducted in this thesis, participants were given a time base intention task, more specifically a pulse intention. However, it is not expected that they have completed their task exactly when they are asked since there is no way to force them to rewrite the tasks at the exact time. Nonetheless, by giving them different time intervals it is expected to observe a significant interaction in the actual delay time they have actually waited until started the second part of the survey with the delay time manipulation condition.

Encoding, delay time, retrieval

Our memory basically works in the following way, first there is an encoding process, our brain gets an information which it perceives in its own way and tries to comprehend it, after that, that information is then encoded and stored (F. I. M. Craik, a. Routh, and Broadbent 1983). Between the encoding process and the retrieval process there is a delay time in which memory usually decreases. Later in the future our brain restores that information by trying to recapitulate the initial processes of encoding (F. I. M. Craik, a. Routh, and Broadbent 1983), however it does not always restore that information when we need it, that is why for example some students remember the answers to a test only after the test is over. Evidence from neuropsychology and neuroscience suggests that the processes involved in retrieval are very similar to those involved in perception and storage of the same type of information thus experimental manipulations that affect one set of processes should have a similar effect on the other set (Bransford et al. 1979; Kolers 1973; Roediger III, Weldom, and Challis 1989; Tulving and Thomson 1973).

However, despite there seem to be similarities, a few studies show there are some differences in both systems when there is divided attention, meaning when people are also at the same time focus on another activity (Fergus I. M. Craik et al. 1996). During the encoding process, performing another task reduces later memory performance, however when attention is divided in the same way during the retrieval process there is virtually no effect on memory performance (Baddeley et al. 1984; Fergus I. M. Craik et al. 1996). One of the studies also found that when manipulated which task people should focus more there was a substantial effect on memory at encoding, but none at retrieval (Fergus I. M. Craik et al. 1996).

This distinction is important since it has been proven that it is possible to manipulate those three stages in order to improve memory performance (Fernandes 2013). For example, some researchers have observed that the perceived importance of the prospective memory task seems to increase the likelihood of prospective remembering (Andrzejewski et al. 1991; Kvavilashvili 1987), others have argued that the degree and type of planning that one does for a prospective memory task affects later remembering (Fernandes 2013; G. Einstein, McDaniel, and Brandimonte 1996) and others observed that directly manipulating the importance of the prospective memory task can affect time-based intentions more than event-based intentions which suggests that they require (or benefit more from) strategic allocations of attention (Kliegel et al. 2001; Kliegel et al. 2004)

Besides that, different characteristics of people might influence the memory performance as several studies showed. For example, several studies reported that gender affects performance in both children, adults and old adults (Ceci and Bronfenbrenner 1985; Kurtz-Costes, Schneider, and Rupp 1995; Huppert, Johnson, and Nickson 2000) which we will analyse in our study and there is evidence that women are better than men in remembering past events (Wang 2013).

In our study there was no manipulation of any sort in the encoding process. Tasks participants had to do in the next seven days were already encoded in their memory, there was no manipulation of the importance of tasks people had to do and we did not manipulate anything when asked them to both write and rewrite those tasks. Thus, the results we got resulted from participants' retrieval process should not be bias in this regard. Also, participants that did our study until the end were very likely not realizing another activity that demanded their attention when they were asked to write for the first time their tasks and therefore there was also no influence in the final results.

Forgetting Curve

When deciding to do this study, I tried to find other studies that showed how fast memory decreases as a function of time. My biggest obstacle, as mentioned in the introduction, was that most of the experiments done so far are conducted in laboratory, ask participants to perform abstract and irrelevant tasks in their lives and involve learning something knew to later access how fast memory decreases for that recently acquired knowledge (Bower 2000). Therefore, any study I mention would have some variations in its methodology compared to the method presented in this thesis, which can lead to different results compared to other authors. However, the most famous and cited study to understand how memory decreases as a function of time is without a doubt the forgetting curve by Ebbinghaus published in his treatise On Memory in 1885 (Ebbinghaus 1913) since it is cited in most of other authors studies.

The forgetting curve plotted by Ebbinghaus, is a well known model that relates the savings percentage as a function of retention interval. What Ebbinghaus did was to learn sets of nonsense syllables such as JEH or YOX and later tested how many of those syllabus he could remember (Ebbinghaus 1913). He would read aloud a series of nonsense syllabus and would repeat them back until he could repeat an entire series perfectly and without any hesitation. While doing this, he would record how many attempts it would take for him to be able to say the series correctly without hesitation. After a while, he would recite that series again until he could say it perfectly like before. Whenever he could not recite it properly, he would relearn the series again. The term savings refer to the the difference between the number of times it would take for him to originally learn a series and the number of times it would take for him to relearn it divided by the original number of trials.

He did this study with many different variations, such as using the number of trials it would take for him to learn the series instead of time spent in the trials, or by changing the length and difficulty of the non-sense syllabus. At the end he come up with what is known as the forgetting curve.

The reason why he decided to use nonsense syllabus was because he wanted to learn materials of homogeneity difficulty (thus avoiding the similarity of familiar words and prose) and he wanted to minimize the influence of prior knowledge (Roediger III 1985; Bower 2000; Ebbinghaus 1913). By doing this, he hoped to get the best unbiased method possible in order to find a theory of how memory works. In fact, when he first started this experiment he had not formulated any hypothesis before in the hope to eventually create one. However, has himself noticed even even nonsense syllables exhibited an "almost incomprehensible variation") in the ease with which they could be learned (Ebbinghaus 1913).

What one notices is that memory decreases very rapidly and later it tends to stabilize. Roughly 70% of memory loss occurs within the first 24 hours and 55% occurs in the first hour. Therefore, in our analysis we decided to use one day of delay time as our biggest delay time interval condition.

However, Ebbinghaus experiment has also got some big critics. First, he was the only person being tested and thus results were completely dependent on his results. Second, since he was both the experimenter and the statistician he probably felled into some unintentional experimental bias. Third, it is argued that the artificiality of Ebbinghaus's experimental conditions guaranteed that nothing important or useful could be found from his research and thus lacking external validity.

Recency and Primacy effect

Many studies found that when presented with a list of words, most people tend to have an easier time remembering the words from the beginning (primacy effect) and from the end (recency effect) of that list compared with the items in the middle of the list (Capitani et al. 1992; Smith 2003; Atkinson and Shiffrin 1968).

In order to understand why this happens, a common explanation is that primacy memory effect is due because the items are encoded and well rehearsed which allowed them to be transferred from short-term storage to long-term memory. The recency effect happens because the just-presented list items are encoded in the short-term store and are immediately available for output when the end of the list signals that retrieval is required (Shiffrin and Atkinson 1969; Glanzer and Cunitz 1966).

Experimental manipulations of stimulus presentation speed that affect only primacy items and postlist interference tasks that affect only recency items strongly support this view (Lewandowsky and Brown 2005; Glanzer and Cunitz 1966; Murdock, Bennet B. 1962). An alternative interpretation is that, because initial items have minimal interference from preceding items and final items have no interference from subsequent items, both primacy and recency effects reflect the operation of a single memory system (Wixted and Ebbesen 1991; Crowder 1982).

It will be analysed if any of those effects happens.

Memory prediction or metacognition

Memory metacognition refers to "people's knowledge of, monitoring, of and control of their own learning and memory processes" (Dunlosky and Bjork 2008). Researches in marketing have usually studied the relationship of people's learning with their actual learning of a new product (Billeter, Kalra, and Loewenstein 2011; Chan, Sengupta, and Mukhopadhyay 2013; Gershoff and Johar 2006; West 1996; Wood and Lynch, Jr. 2002). However as stated before in this thesis we are not asking people to learn new things, we just want to test their memory performance. What the other studies found is that metacognition influences learner's behaviour by informing whether more study is needed or not (Nelson and Dunlosky 1991).

There is only one study we found that investigates people's prediction about their future memory performance (Fernandes 2013). In this study participants were exposed to a list of shopping items and were asked to predict how many of them they would be able to remember after 10 minutes. The shopping items were either familiar or unfamiliar and in the end results showed that in both scenarios on average memory prediction was higher than memory performance. However, there was only a significant overestimation on the list of items that were unfamiliar but there was no significant overestimation in the list of familiar items.

Previous study on memory metacognition shows that people are especially likely to be overconfident about their memory when making memory predictions right after being exposed to the items to be remembered (Rhodes and Tauber 2011). This is consistent with the notion that recent exposure to a task leads to a temporary boost in the action's memory activation, which does not necessarily mean that that action will be more likely to be retrieved after a certain period of time (Graf and Mandler 1984; Srull and Wyer 1979).

In our study, right after asking participants which tasks they need to do in the next seven days, we asked them how many of those tasks they believe would be able to remember after a certain amount of time. Therefore, we expect that those tasks are highly activated in their minds and that their predictions are overestimated. Nonetheless that does not necessarily mean that our results will be significant because since we are asking for tasks people intend to do in the next seven days we expect to find a lot of familiar tasks, which as mentioned above did not provided significant results.

Short term and long term memory

As it has been shown so far, not all our memories work in the same way, sometimes there are things we need to remember for a long spam of time (like driving) and others we only need to remember for a very brief moment (like knowing which number is our ticket in a waiting line).

Therefore, previous authors tried to come up with a model divide in three structural components: the sensory register, the short-term store, and the long-term store in order to explain how our brain selects what is intended to stay in our memory for longer periods of time and what is not.

At first we receive an input of sensory information which enters in the sensory register where it resides for only a few seconds before it quickly decreases and is lost (Averbach and Coriell 1961). Sensory register refers to our senses such as vision, audition, tact, smell, taste and any other human sense. During our investigation we found some references to how sensory register works for short-term visual image (Sperling 1960; Sperling 1963; Averbach and Coriell 1961; Estes 1964; Estes and Taylor 1966).

After that, the sensory information is identified, recoded and enters in the short-term memory. The short-term store is the subject's working memory, it receives selected inputs from the sensory register and also from long-term store. Information entering the short-term store is assumed to decay and disappear completely, but the time required for the information to be lost is considerably longer than for the sensory register, while the first only takes a few miliseconds this one takes about 30 seconds to completely disappear (Atkinson and Shiffrin 1968). The characteristic of the input of sensory information received from the sensory store may not have the same characteristic when it is transferred for short-term memory. For example, a word presented visually may be encoded from the visual sensory register into an auditory short-term store.

Finally, the long term-store differs from the other two since information stored here does not decreases in the same way. All information is eventually lost from both sensory register and short-term store but it stays practically forever in the long-term store (Atkinson and Shiffrin 1968). However, it may be modified or be temporarily unavailable to obtain due to the incoming of new information (Atkinson and Shiffrin 1968).

The short term memory models were partly inspired by neurological patients with organic amnesia caused by bilateral damage to the media temporal lobe and hippocampus. Such patients have an intact short-term and long-term memory, but are greatly impaired in transferring new verbal information to long-term memory.

The common explanation for the transfer of information from the short term memory to long-term memory is the amount of times the information is rehearsed, how it is recorded and which retrieval strategies people use (Atkinson and Shiffrin 1971). By transferring information from one system to another that information is not necessarily erased from its initial origin.

Methodology:

For the collection of the data I conducted a survey online made in qualtrics. The survey was available in both English and Portuguese. I decided to opt for this method since it is easier to reach a larger audience and because the delivery process would be the most standardized possible. Also, since the method of the study focus on time-base intention, asking personally for people to conduct a survey face to face could bias the results since the simple fact of me being present could have in an influence in respondents' answers, like me being the stimuli for event base memory, people could feel pressured to finish the surve, among other unpredictable variables that could bias the results. Due to a technical feature of the study that allowed to control how much time participants spent on the survey, participants were asked to not do the survey on mobile devices such as tablets or smartphones.

The survey aimed to evaluate respondent's memory prediction (metacognition) and their actual memory performance for different time intervals and it was slightly different for each time interval, however the description bellow portraits the general experiment.

To test their metacognition and memory performance, respondents were asked to write five tasks they wanted to do in the next seven days and were asked not to use any reminders. After that, they were asked how many of those tasks they believe they would remember after a certain amount of time. Then they would be asked to wait for that amount of time, during this time they were told they could do whatever they want, the idea was to let them proceed with their lives as they would normally do before they needed to do the intended action. For example, they would be asked how many tasks they believe they would be able to remember after ten minutes, then they would be asked to wait ten minutes, after ten minutes they were instructed to write the same five tasks again. Participants were informed that the order of the tasks did not need to be the same as they wrote before, neither it was important if they could not remember every task. Finally, respondents were asked for their gender, age and professional occupation. The text was framed in the exact same way in each delay time condition with the only changing being the amount of time they had to wait.

We used five different time intervals: no delay time, 10 minute delay, 30 minutes delay, 1 hour delay and 24 hours delay. Each participant was randomly attributed one of those time intervals and they could only answer the survey once. As seen before, we decided to use this delay times because according to the forgetting curve we expect to see a higher decrease in memory performance by the end of the first hour and after 24 hours the decrease should level to its lowest value.

<u>Delay time of 10, 30 and 60 minutes</u>

For a delay time of 10 minutes, 30 minutes and 1 hour, the survey had a timer that did not allowed participants to move forward until that time had passed. Respondents were asked to keep their tab open since if they closed the survey and come back again later, the timer would reset. They were told they could do anything during this time. To browse the net, they could open new windows and tabs as long as they did not close the survey's tab. The surveys with a delay time of zero minutes were exactly the same but since there was no need for the timer we never asked them to wait.

Delay time of 24 hours

For the 24 hours delay time, since it is impossible to keep people with their tabs opened for 24 hours, the questionnaire was divided into two parts. In the first part respondents were informed that their phone number was required (if they were Portuguese), as well as their email address, in order to send them the second part of the survey. After that they were asked to write the five tasks they wanted to do in the next seven days and how many of them they believe would be able to remember after 24 hours. Finally, they were given the option to say how they preferred to be contacted.

In the next day respondents received via email a link to the second part of the survey, as well as a text message (only Portuguese numbers received a text message) to remind them to complete the survey. There was no fixed time to send the email, nevertheless I tried to send the email 4 hours earlier than the 24 hour deadline because this way respondents would at least have waited 20 hours and second because I noticed that many times people answered the survey at night and this way I would rather have them answer earlier than sending them the email when they were already asleep and getting higher variation in this delay time condition. The email message was standard to every participant. It had the time expressed in GMT in which respondents should fill the survey and the link to it, it also thanked for their participation. Regarding the text messages, they were sent closer to the deadline because people always have their cell phones with them and see text messages almost instantaneously. The text message would simply say that the second part of the survey had already been send to them via email and also had the hours in which they should fill it.

Once opened the survey, they were asked again to write their phone number and email address in order since this way it would be possible to track their responses, then they were asked to write the same five tasks they wrote the day before and finally they were asked for their gender, age and professional occupation.

Distribution:

The target focused on this experiment was college students in order to have a more homogeneous sample, however that did not exclude other people to answer the survey too. The questionnaire was distributed in several ways through the internet but mainly through Facebook. In Facebook there were five different approaches:

- The survey was posted on the researcher mural;
- It was shared/posted on the Facebook mural of at least 15 friends and family members of the researcher (possibly more, however this was the amount that was tracked);
- It was sent personal messages to each person on the researcher's Facebook friends list asking them to answer the survey (327 people);
- The survey was distributed in three Facebook groups whose purpose was to share surveys for college and the way to get answers was by filling other people's surveys;
- The survey was also shared on roughly 60 college groups of marketing or management across all over the world.

Regarding the other distribution channels:

- The researcher sent an email with the survey for all of his 320 email contacts;
- The survey was posted on reddit in their marketing subreddit and academic subreddit;
- It posted on swap survey.

Results analysis

A total of 875 responses were received. From those responses, only 299 participants finished the study and 5 of them were removed from the analysis either because their answers were invalid or because there is strong reasons to believe they were participants who responded twice to the survey. At the end that leaves us with a total amount of 294 responses and an approximate drop out rate of around 66%.

While analysing the data, a few measures were taken to make sure the same participant did not answer the survey twice. The parameters analysed were the IP address of respondents, the tasks they listed and their demographic answers. Those who had the same IP address, the same demographic answers and wrote very similar tasks were considered to be the same respondent. To those cases, it was only used the data collected from the first survey they did and ignored the data from the other surveys they took. Also, since roughly 66% of respondent did not finish the survey and roughly half of them would quite the survey when they were asked to wait for their corresponding delay time, which indicates that they did not want to wait and thus it is unlikely that people would answer the survey several times.

Nevertheless, all the five delay time conditions had more than 30 responses which allow us to make with some certainty extrapolations for a bigger amount of answers. I would also like to point out that while running the experiment the amount of answers for each delay time condition would decrease for bigger delay times (except for the 24 hour condition). Therefore, I was forced to show the one hour delay time condition more often than any of the other conditions and that is why it is observed a high number of responses for the one hour delay time condition (as explained before participants were only assigned to one time interval and did not know there were other time intervals).

The analysis will be made only taking into account those 294 completed responses. Out of those responses 36,7% were from male participants and 63,3% from female participants. Regarding age differences, there was a very homogenous sample with 76,5% of participants aged between 18 and 25 years old, 21,1% with more than 25 years old and only 2,4% with less than 25 years.

The rest of the analysis will be divided into two parts. First it will be analysed how fast memory decreases for tasks and second it will be tested if some of the findings in the literature are observed in the experiment.

First part:

The analysis of the results was performed using the Analysis of Variance (ANOVA) that basically compares whether the means of each group was different from each other.

The first ANOVA intended to test whether the manipulation on the delay time interval worked. Therefore, it was measured the time interval participants had between the first part of the study (in which they are asked to list the tasks) and the second part (in which they are asked to list again the tasks to test their memory). What is found is an effect of the delay time interval condition (immediate, 10 minutes, 30 minutes, 1 hour, 24 hours) on the effective time interval participants spent waiting between the first part of the study and the second part of the study ($F(4, 289) = 463.00$, $p < .01$). As seen in table 1 below, the time interval participants take between the first part and the second part is much higher in the 24 hours condition (M = 96585 seconds) than in the 1 hour condition (M = 4902). It is also observed an increase in the standard deviation for the highest **delay** time conditions which suggest that participants did not use any method to remember them to finish the survey (such as setting the time in an alarm clock) and probably relied in their internal time monitoring processes.
The second ANOVA intended to test whether the manipulation on the delay time interval had an effect on actual memory performance. The results show an effect of the time interval condition (immediate, 10 minutes, 30 minutes, 1 hour, 24 hours) on the number of tasks participants remembered ($F(4, 289) = 11.60$, $p < .01$). The longer participants needed to wait before they could rewrite the tasks again, the worse their performance was. As one can observe in table 2, participants indeed remembered fewer tasks in the 24 hours condition (M = 4.15 tasks) than in the 1 hour condition (M = 4.59 tasks, $F(1, 289) = 14.61$, $p < .01$), which was not significantly different from the performance in the 30 minutes condition (M = 4.66 tasks, $p = .64$). However, the memory performance in the 1 hour condition (M = 4.59 tasks) was significantly lower than the performance in the 10 minutes condition (M = 4.82 tasks, $F(1, 289) = 4.35$, $p < .01$).

Table 1 Memory performance per condition

Time delay condition	Number of Participants	Performance		
		Mean	Mean as %	Std Dev
immediate	74	4.89	97,8	0.31
10 minutes	66	4.82	96,4	0.43
30 minutes	32	4.66	93,2	0.60
1 hour	74	4.59	91,8	0.66
24 hours	48	4.15	83	1.07

These results indicate that there is a decline of memory over time, but that the strongest decline is after 24 hours.

Second part:

Contrary to some literature, the results show that gender had no effect on either memory prediction and memory performance. The average results for both men and women were so similar in the two conditions that it was not even used an Anova to analyze the data. As shown in the table bellow the number of tasks participants remembered were almost the same (4,64 for female and 4,68 for male), as well as their predictions (4,32 for female and 4,56 for male).

Table 2 Gender effect on memory prediction and memory performance

Gender	Average Prediction	Average Performance
Female	4,32	4,64
Male	4,56	4,68

The third Anova used intended to test whether the order in which tasks were written had an effect in its likelihood to be remembered later. As we can observe in table 4, participants indeed remembered more the first task they wrote in contrast to the other tasks which was significantly different from the performance of the other tasks (M= 0,97, $p<0.02$), which indicates there is a primacy effect. However, the memory performance for the last task (M=0,9252) was equal to the second task (M=0,9252) and worst than the third (M=0,93,20), which indicates that there is no recency effect.

Table 3 Relation of order of tasks with their likelihood to be remembered

Order of tasks	Nº of tasks remembered	Percentage of tasks remembered	Total number of participants
Task 1	286	97,28%	294
Task 2	272	92,52%	294
Task 3	274	93,20%	294
Task 4	265	90,14%	294
Task 5	272	92,52%	294

Finally, it was tested the effect of condition on predictions of memory. Results found no effect of the time interval condition (immediate, 10 minutes, 30 minutes, 1 hour, 24 hours) on the number of tasks participants predicted they would remember ($F(4, 289) = 0.52$, $p = .72$). As it is observed in table 5, participants predicted they would remember a similar amount of items in each condition. There is no significant differences between conditions (*p*s > 0.22) which we expected since most tasks were familiar to participants (like cleaning their house or doing shopping). However, what is surprising is that when we compared the averages of both prediction and performance we found the opposite to what we expected. Memory performance was on average higher for every delay time condition.

Table 4 Memory predictions per condition

Time delay condition	Number of Participants	Prediction	
		Mean	Std Dev
immediate	74	4.49	0.91
10 minutes	66	4.41	1.11
30 minutes	32	4.56	0.95
1 hour	74	4.30	1.17
24 hours	48	4.38	0.87

These results indicate that even though time interval had a strong effect on memory performance for tasks one intends to perform, it has no effect on memory predictions.

Conclusion:

The main aim of this study was to find how fast retrospective memory decreases for everyday tasks. To do that it was conducted an online survey in which participants were asked to write which tasks they needed to do in the next seven days and then they were asked to rewrite them back.

By conducting the survey online, we believe that we managed to avoid manipulating the encoding process and the retrieving process since there was not any additional attention demanding activity being performed in both processes (encoding and retrieving) and there was not given any special focus in a particular task over other. Furthermore, participants were asked to not use any reminders and, even though it was not possible to control that condition, we believe they complied since the big drop-out rate proves that the waiting time was a tedious feature that participants wanted to avoid and an additional work such as writing a reminder would only increase the drop-out rate.

Also, the online survey manages to focus on time-based intentions rather than event-based intentions which means that participants did not needed to monitor and looking in the environment for target cues to remember to finish their survey and thus whatever processes are involved in the retrieval process should be more homogeneous.

Unfortunately, because this was an online survey participants had no incentives to stay until the end and had total freedom to leave whenever they want without any consequences. As expected, it is observed that the majority of participants left when they reached the phase in which they were asked to wait before starting the second part of the survey. This result indicates that the delay times were too much for them to bear. These reasons combined resulted in an observed drop-out rate of around 66%.

Another aspect of this study is the fact that it is distinct from most of the previous studies in memory. The study was not conducted in a laboratory, participants were not asked to learn new things to later be remembered and finally, instead of meaningless and abstract tasks, participants were asked to remember real life things that are important for them in their daily lives. By doing this there is less control over the different variables that affect participants' memory performance and thus results can not be fully explained but in return it is possible to get a view of how retrospective memory performs in real life.

Results show that indeed memory decreases the more time passes by, which alone is not interesting without further analysis since it is of common knowledge. However, the data shows that there were two significantly decreases in retrospective memory performance. First, there is a significant decrease between a delay time of 10 minutes and one hour (from 3,6% to 8,2%), and second there is a significant and bigger decrease in the retrospective memory between a delay time of one hour and 24 hours (from 8,2% to 17%).

Delay times between one hour and 24 hours were not analysed since while looking for previous experiments, the highest rates of decrease in memory were usually observed at the beginning, while by the end the decrease rate would slow down and eventually level up. Comparing with the forgetting curve plotted by Ebbinghaus, the decrease in memory is not as fast as expected. In Ebbinghaus experiment there is a decrease of about 55% of memory performance after the first hour, however in this study that decrease is of only 8,2%. Comparing to one-day difference, that decrease is roughly 70% while in this study the decrease was of 17%.

Another observed result was that even when there was no delay time there was a slight decrease in memory performance (2,2%), which might seem to make no sense but in fact it was already proven before that memory decreases after even just a few seconds and certainly it took at least a few seconds for participants to finish rewriting their tasks.

While conducting this study, it was decided to test if some of the findings of previous authors would also held truth in this study like if there there is a primacy and recency effect as shown in Ebbinghaus experiments, meaning that people tend to remember better their first and last task (Ebbinghaus 1913; Murdock, Bennet B. 1962; Capitani et al. 1992); if gender affects memory performance (Ceci and Bronfenbrenner 1985; Kurtz-Costes, Schneider, and Rupp 1995; Kvavilashvili, Erskine, and Tan, n.d.; Huppert, Johnson, and Nickson 2000) and if people overestimate their performance (Fernandes 2013). What we found out is that those theories tested in laboratory did not happened in our experiment. We did found a primacy effect, meaning that the first task participants wrote was significantly most likely to be the one people remember the most, however there was no recency effect. We also did not find any impact of gender in both memory prediction and in memory performance. Finally, we were expecting to find that people overestimate the amount of tasks they will remember but we were not sure if it would be statistically significant since the tasks participants wrote were familiar to them. We found no significant difference between participants' prediction and their performance and it is actually curious to see that predictions were actually lower than performance in each delay time condition (with the exception of the longer delay time condition).

<u>Limitations:</u>

- There is no way to be sure that respondents did not use reminders.

- Because the delay time conditions of 10 minutes, 30 minutes and one hour delay, there was a timer on the survey that required participants to keep their tabs opened and thus they were asked to complete the survey on their computers and not using their mobile devices such as smartphones or tablets. Because of this technical feature, it is probably safe to assume that it would be possible to reached a broader audience and get more responses (which would strengthen the results of our study) if the timer was turned off.

- The difficulty of the retrospective memory task was maybe very low. In order to see clearer results, people should had been asked to write more tasks that they needed to do in the next seven days. Nevertheless, the main goal was to see the rate at which memory decrease for tasks, therefore the results should be very similar if one increases or decreases the number of tasks people have to remember.

- The text of the survey was changed a few times after being launched to address some problems, namely the big drop out rate of respondents. Initially every respondent was asked for their phone number and email address in order to give the exact same condition to every participant. However, since most respondents would not provide their contacts, and thus were not able to move on in the survey, later only respondents in the 24 hour delay time condition were required to provide their contact which might have bias the results for this condition compared with the others.

- Respondents do not always list their tasks in a way that it is clear they remembered them or not. For example, one respondent listed that he “had to go to the dentist” and later he wrote that same tasks as “appointment Rafinha”. Luckily this respondent provided his contacts and when asked he said both were the same thing, he had to take his son (Rafinha) to the dentist.

For future researchers we warn them to think about this as a trade off. As explained above, asking for personal details such as phone number and email address will decrease the amount of people willing to answer the survey. However, not asking for that information will harm the quality of the analysis since participants might write the same task in a very different way and one is left guessing if it is the same task or no.

- The timer on the survey did not guaranteed that people answered again after exactly 10 minutes, 30 minutes and so on. If you conduct an online survey, it is probably safe to assume that it is impossible to guarantee that people will write the tasks again after an exact delay time. To guarantee perfect time accuracy, it is probably better to conduct the study offline, but then there is other problems as mentioned before such as: it will be more costly and time consuming to run the experiment (specially assuming the offline experiment would have the same or at least a similar drop-out rate) and there is a possibility to mixture the results of a time-based intention activity with event-based intention activity (if the experiment is not done on a controlled environment).

- Some may argue that in the real world there is a cost for not conducting the tasks until the end and this study does not replicate those costs which might influence performance.

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