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**IMAGINATION INFLATION WITH POSTTEST DELAYS:
HOW LONG WILL IT LAST?**

by

Charles G. Manning

A dissertation submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

University of Washington

2000

Program Authorized to Offer Degree: Psychology

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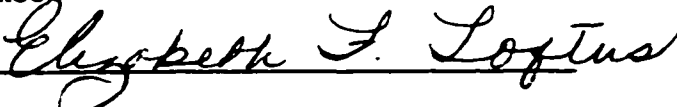
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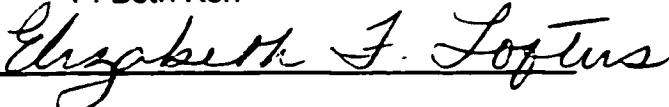


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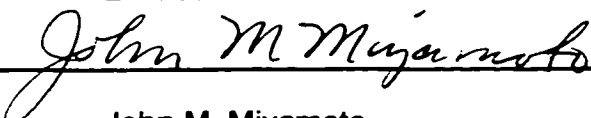
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Abstract

Imagination Inflation with Posttest Delays:

How Long Will It Last?

by Charles G. Manning

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When attempting to recall past events we often imagine what might have been. There is growing evidence that those acts of imagination may lead to memory for events that never happened. Imagination inflation occurs when the subjective probability that an event occurred increases after it has been imagined. Imagination inflation is typically demonstrated using a pretest-posttest design. A familiarity-attribution model for imagination inflation is proposed. The model predicts that as memory for what was imagined decreases the ability to attribute familiarity also decrease and this produces larger amounts of imagination inflation. In this study the time between the imagination activity and the posttest was 1, 7, or 14 days. Higher levels imagination inflation were found at the longer delays. When subjects recalled what they imagined pretest to posttest changes were not different across the 3 delays. When subjects did not recall what they imagined the difference between their pretest and posttest ratings increased at a steady rate from 1 to 7 and 14 days. The familiarity-attribution model accounts for these effects.

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Introduction

Suggestion of Autobiographical memories

Often when we are asked to remember some long forgotten event we will imagine what might have been. Suppose you were asked about the time you put your hand through a window when you were a kid. If you could not immediately recall the event you could try to imagine it. You might try to imagine your childhood home, which window it might have been, who was with you at the time, and what happened after the window broke. The image you produce might serve as a retrieval cue but what if the event never happened? There is growing evidence that the mere act of imagining an event may make the event seem like it could have happened whether it really happened or not.

This evidence comes from a line of research that started late in the last century. In the 1980's and 1990's there was a controversy over whether techniques used by therapists (such as imagination exercises) could cause patients to remember events that never happened (Kihlstrom, 1994; Lindsay & Read, 1995). Therapists were attempting to treat psychological problems they thought were caused by childhood traumas such as sexual abuse. It was theorized that those traumatic memories had been repressed or hidden from conscious recollection. Some therapists believed that to treat the psychological problems the memories of abuse had to be "recovered," meaning they had to be brought to consciousness (Claridge, 1992; Kihlstrom, 1994). The techniques used to recover those memories ranged from the use of drugs like sodium amytal to the use of hypnosis and guided imagery (Kihlstrom, 1994; Lindsay & Read, 1995). An important question is whether the

memories recovered using those techniques are memories of true events or false memories induced by therapy.

In response to recovered memory controversy a number of studies were conducted that demonstrated the implantation of false autobiographical events (e.g. DuBreuil, Garry, & Loftus, 1998; Hyman, Husband, & Billings, 1995; Loftus & Pickrell, 1995; Mazzoni, Lombardo, Malvagia, & Loftus, 1999). A variety of procedures designed to influence the subjects' memories were used. These procedures typically included false feedback suggesting the subject had in fact experienced the event. In some experiments the false feedback was in the form of a suggestion that others could remember the made-up event (e.g., Hyman et al., 1995, Loftus & Pickrell, 1995). Others suggested that subject's personality indicated they had experienced the event (e.g., DuBreuil et al. 1998) or that the content of the subject's dreams showed the subject had experienced such an event (e.g., Mazzoni et al. 1999). For example, Loftus and Pickrell (1995) and Hyman et al. (1995) told subjects that another family member had recalled a made-up (false) event. Later subjects were asked to recall that false event. Loftus and Pickrell had each subject read a description of a "false" event (being lost) allegedly given by the subject's relative along with three "true" events the subject's relative really did describe. They were then asked to write what they remembered about the each event. Subjects were interviewed about each of the events 1 to 2 weeks later and again 1 to 2 weeks after the first interview. A quarter of the subjects (6 of 24) ended up developing some memory of the false event. Hyman et al. (1995) used similar procedures, a series of two to three interviews two days apart. After the third interview just over one quarter (13 of 51) of the subjects were recalling the false event.

It is worth examining the components of these experiments to get an idea of what influences might be producing false memories. One set of possible influences is the social situations created in experiments such as Loftus and Pickrell (1995) and Hyman et al. (1995). In both experiments subjects were told that one of the purposes of the experiment was to compare the subjects' memories with those of their relatives. Thinking that their memory performance would look poor if they did not remember an event that others did, may have pressured subjects to produce a memory of the false event. Subjects in both experiments were also told that one of the goals was to see how detailed their memories were. Thus in the interviews subjects may have felt obliged to recall detailed events in order to please the interviewer or experimenter. Hyman et al. (1995) intentionally capitalized on that demand characteristic by telling the subjects that one of goals of the experiment was to produce more complete and accurate recall. Beyond these social influences other less obvious internal influences, such as imagination, could be at work. For example, in both experiments subjects were asked to think about the events between interviews and try to remember more. Could just thinking about or imagining an event cause a memory of that event to develop? The imagination inflation effect indicates that it could be a start.

What is Imagination Inflation?

Imagination Inflation occurs when the subjective probability that an event occurred increases (inflation) after the subject has produced a mental image of the event (imagination). The procedures which have been used to produce this effect in the lab involve a pretest-posttest design. Garry, Manning, Loftus, and Sherman (1996) used a pretest they called *The Life Events Inventory* (LEI). The LEI asks subjects to indicate how confident they are that they experienced certain events

during their childhood (e.g. Before you were 10 years old did you break a window with your hand?). The LEI uses an 8-point scale. The scale's anchors are 1, "definitely did not happen", and 8, "definitely did happen". After taking the pretest subjects were asked to imagine some of the events while other, not-imagined events, served as controls. The posttest was the same LEI as the pretest. Garry et al. measured inflation by looking at the relationship between pretest and posttest ratings. If the posttest rating for an event was greater than the pretest rating (that is moved away from the "did not happen" anchor and toward the "did happen" anchor) then the subject had "inflated" on that event. For each of the critical events more subjects who imagined the event showed inflation than subjects who did not imagine that event.

Recent Research

The imagination inflation finding has been replicated using both autobiographical childhood events (Paddock, Joseph, Cahn, Terranova, Manning, & Loftus, 1998; Heaps & Nash, 1999; Paddock, Noel, Terranova, Eber, Manning, & Loftus, 1999; Manning, Garry, Assefi, & Loftus, 2000) and using more recent activities (Goff & Roediger, 1998; Thomas, 1999). Studies on imagination inflation for autobiographical memories have looked at the conditions under which imagination inflation occurs and some individual differences associated with it.

Conditions associated inflation

Imagination inflation appears to be a robust phenomenon that occurs under a variety of procedures. Manning et al. (2000) had some subjects either imagine events happening to themselves when they were young or imagine events happening to someone else, someone with whom they did not identify when that person was young. They found that imagining an event happening to someone else produces as

much inflation as imagining an event happening to the self. Imagination inflation has been produced using extensive interventions such as a videotape of a 15 minute guided visualization task led by an experienced clinical psychologist (Paddock et al., 1998). It has also been produced using minimal interventions such as imagining actions for just a few seconds (Goff & Roediger, 1998) or a brief imagery exercise presented via audio-tape (Paddock et al., 1999). Goff and Roediger (1998) investigated imagination inflation for recent events preformed (or not) in the lab. They found that subjects were more likely to say they had preformed an action they had not preformed after they had imagined it. Goff and Roediger also found that the more times the non-preformed action was imagined the more likely subjects were to show imagination inflation for that action (say they had preformed it). Thomas (1999) used similar procedures and found inflation with bizarre actions as well as with more common actions.

Individual differences and inflation

Many theories relating to the recovery of repressed memories rely on the mechanism of dissociation (Briere & Conte, 1993). Dissociation is a failure to integrate experiences, memories, feelings, and actions into consciousness (Bernstein & Putnam, 1986). An often used example is the experience people have of driving a well known stretch of road and when they get to the end of journey they don't remember it (Bernstein & Putnam, 1986). Several theoretical models of dissociation have been proposed including models that emphasize modulating states-of-consciousness, self-hypnosis, neurological systems, and malingering (van Ijzendoorn & Schuengel, 1996). The basic of idea of many theories of repressed or hidden memories is that those memories become inaccessible because they are so traumatic

and awful to recall that they are dissociated from awareness. In other words, traumatic experiences cause dissociation. This view is consistent with findings that people who recover memories or have other mental disorders such as post-traumatic stress disorder or multiple personality disorders and also score high on dissociativity scales (Bernstein & Putnam, 1986; Briere & Conte, 1993). However the causal relationship could also go in the other direction, people with a tendency to dissociate may be those who are more likely to develop, possibly false, memories of traumatic experiences. Recent findings have linked imagination inflation with some individual differences such as the tendency to dissociate. Paddock et al. (1998) and Heaps and Nash (1999) found a correlation between the Dissociative Experiences Scale (DES) developed by Bernstein and Putnam (1986) and imagination inflation.

Heaps and Nash also found that hypnotic suggestibility (measured with Waterloo-Stanford Scale of Hypnotic Susceptibility) predicted inflation. They interpreted these findings as suggesting that "stable and intrinsic aspects of the way in which an individual processes information may make the creation of false beliefs more likely" (Heaps & Nash, 1999, p. 317). They also found that a measure of susceptibility to the influence of authoritative interrogation (measured with the Gudjonsson Suggestibility Scale, GSS) did not predict inflation. Because of this finding they argue that the creation of false beliefs and imagination inflation may not be due to individual susceptibility to external influences such as social compliance or reliance on authority.

Paddock et al. (1998) found a correlation between external locus of control (as measured by the Adult Nowicki-Strickland Internal External locus of control scale, ANSIE) and imagination inflation. While at first this finding may seem to go against

Heaps and Nash's contention that imagination inflation relies on internal cognitive factors and not susceptibility external suggestion, that is not the case. It is important to keep in mind that locus of control refers to the individual's beliefs about what influences him or her and not actual influences. In fact a correlation between beliefs and imagination inflation is consistent with the contention that internal cognitive factors are important in creating imagination inflation (Heaps & Nash, 1999).

Because perceptual characteristics are important in determining whether memories come from real or imagined events (Johnson & Raye, 1981) one might suspect that those who have the ability to produce particularly vivid images might make more of these source monitoring errors. The Vividness of Visual Imagery Questionnaire (VVIQ) was developed as a measure of the ability to produce vivid imagery. And, high scores on the VVIQ have been related to source monitoring (the process of attributing memories to a source such as a real or imagined experience) in a number of studies (see Heaps and Nash, 1999). It would seem sensible to hypothesize that imagery vividness would also be related to imagination inflation. However, Heaps and Nash did not find a relationship between imagination inflation and VVIQ scores.

Not only does a person's general ability to produce vivid images seem unrelated to imagination inflation the vividness of particular memories for imagined events also does not seem to predict inflation. Manning et al. (2000) had subjects rate the images they produced on several characteristics including vividness, feelings, sounds, and smells. Image ratings were made a few minutes after subjects had imagined the events so the ratings would be based on subjects' memory of the

image and not on image as experienced at the time it was produced. However none of the characteristics were found to predict inflation.

How does Imagination Inflation happen?

There are several theories and lines of research that help us understand why imagination inflation might be occurring including the use of heuristics in making judgements, source monitoring, and models of implicit and explicit memory. We need not think of these approaches as being mutually exclusive because they relate to imagination inflation in different ways.

Heuristics: familiarity and availability increase LEI ratings

It could be that subjects are basing their LEI ratings on the familiarity or availability of the event in question. Arkes, Hackett, and Boehm (1989) manipulated familiarity by repeating some statements and not others. They found subjects rated repeated statements as more valid than non-repeated statements. This was true regardless of whether or not the statement was originally perceived as true or false. Arkes et al. concluded that familiarity mediates the relationship between repeated exposures and judgements of validity. To extend this to the LEI, if subjects are using familiarity to respond to a statement like "Before you were 10 years old you found a \$10 bill in a parking lot" then we would expect to see that, the more familiar the statement is, the more valid it would be judged. Because of the affirmative nature of the statement, if it is judged to be valid then it should be judged as likely to have happened.

Related to familiarity is the construct of "availability". Kahneman and Tversky (1973) are well known for showing how the use of heuristics, such as availability, cause us to judge events as more or less probable. They manipulated availability by

using stimuli that were either easy to recall (e.g. pairs of related word or famous names) or more difficult to recall (pairs of unrelated words or less famous names). They found that the easier it was to recall examples of a category the more frequent or probable that category was judged to be. In the case of the LEI the more readily subjects can bring an instance of an event to mind the more probable the event would seem.

Manning et al. (2000) found that subjects who imagined other people as the protagonist in imagined events inflated as much as those who imagined themselves as the protagonist in the event. This result fits well with the availability heuristic. If imagination inflation were due to a change in global judgements of frequency, then we would expect that inflation might occur whenever an instance of that event occurs. Inflation then would be independent of many of the characteristics of that event such as the particular imagined participants in the event.

It is important to note that while familiarity and availability are predicted to have the same relationship to LEI ratings they are somewhat different constructs. What do we mean when we say something is familiar? Dictionaries use words like "knowledge" or "acquaintance" to define familiarity. When we use familiarity we often use it in phrases like "feeling of familiarity" or a "sense of familiarity." From a cognitive prospective, "familiarity" can be thought of as sense of knowledge or in more technical terms as a meta-cognitive judgement about what information we have. Judgements of familiarity can be made without retrieving the information. For example, it is not necessary to bring to mind a mental map of your hometown to make a judgement that you are familiar with the roads there. One may not be able to retrieve that information but may still have a sense that they are familiar with it. That

is, the information may not be available but still familiar. So, while you may not be able to recall the exact path from the one place to another (the memory is not available), you might be confident that you could easily navigate that path if you were in the context (it is familiar).

Reality monitoring moderates imagination inflation.

Source monitoring is the process of attributing memories to a source. Reality monitoring (Johnson & Raye, 1981) is a subset of source monitoring in that it refers to the process of deciding whether a memory came from an internal source (e.g. imagination) or an external source (e.g. perception). The reality-monitoring approach proposed by Johnson and Raye assumes that externally generated and internally generated memory traces are stored together. When the memory is retrieved it is attributed to a source through a decision process. That process uses attributes of the memory such as information related to sensation and cognitive operations to attribute the memory to a source.

Reality monitoring could be applied to imagination inflation if subjects are misattributing the memory generated during the imagination task to an external source. When imagining an event, say finding a \$10 bill in a parking lot, a memory trace is created. That trace could be retrieved when "Did you find a \$10 bill in a parking lot?" is asked on the posttest LEI. If a source monitoring error occurred and the memory is attributed to a perceived or experienced event then subject would show high confidence that they found a \$10 bill in a parking lot.

Implicit and explicit memory

Both the familiarity approach and the source monitoring approach account for imagination inflation by looking at a decision process. The difference between the

familiarity approach and the source monitoring approach is the subject of that decision process. With source monitoring, the decision is about an explicit memory, while with the familiarity approach, the decision is about an implicit memory. When we talk about explicit memory we mean the conscious recollection of information while implicit memories are implied by measures that indicate the presence of information but do not necessarily require conscious recollection (Schacter, 1990). Schacter points out that indirect and direct tests of memory, while not exactly the same, are roughly equivalent to implicit and explicit tests. Which of these categories the LEI fits into is not obvious. In one sense the LEI is a direct test (i.e., explicit memory) because we are directly asking about a particular event. Imagination inflation could be accounted for by explicit memories generated by the imagination sessions being misattributed to childhood experiences. On the other hand the LEI does not ask for explicit recall of an event, just a probability or confidence rating. As discussed earlier, the LEI rating may be based on a meta-memory judgement and not on the explicit retrieval of a memory. In imagination inflation the LEI ratings, or more precisely the change in LEI ratings, becomes an indirect test or a measure of implicit memory. Imagination inflation could be seen as resulting from implicit memories for the imagined events.

Although the distinction between implicit and explicit memory is an useful one it need not be the case that that the LEI is measuring one or the other or that imagination inflation is exclusively an effect of one form of memory. Consider what subjects might be doing when answering a LEI question (see Figure 1). When asked to rate statements like "Before you were 10 years old did you break a window with your hand?" subjects who explicitly recall such an event should give the statement a

high rating, probably an eight (definitely did happen) on the LEI scale. Subjects who do not explicitly recall a similar event will choose a rating based on attributes like familiarity. The situation gets a bit more complex after the subjects have imagined the event. After subjects have imagined the event there is an additional possibility of an explicit memory for the imagination session. Again, subjects who can recall such an event should give the event a high rating while subjects who do not recall such an event will base their rating on other information such as familiarity. If the subject does not remember the event and the event does not seem familiar then the subject would be expected to give the event a low rating. However, if the event does seem familiar then whether the subject gives the event a lower or higher rating might depend on whether or not the subject can attribute that familiarity to imagining the event. If the subject remembers imagining the event then any familiarity could be attributed to the imagination session and the subject would lower their rating accordingly. But if there is no memory for the imagination session then the additional familiarity might make the event seem more likely and thus increase the LEI rating.

This approach is similar to one taken by Jacoby and Whitehouse (1989). They manipulated the familiarity of words in recognition test by subliminally presenting the target word just before the subject was to indicate whether the word was on list they studied earlier. For target words that had not been on the studied list, subjects were more likely to say the word had been on the list when the word was subliminally presented before the recognition task than when no word or a different word was presented before recognition. Jacoby and Whitehouse concluded that the subliminal presentation increased familiarity and this increased familiarity caused subjects to think that the word had been on the list they studied when it had not.

Similarly subjects may be basing their LEI rating on the familiarity of the LEI item and giving those items with higher familiarity a higher rating.

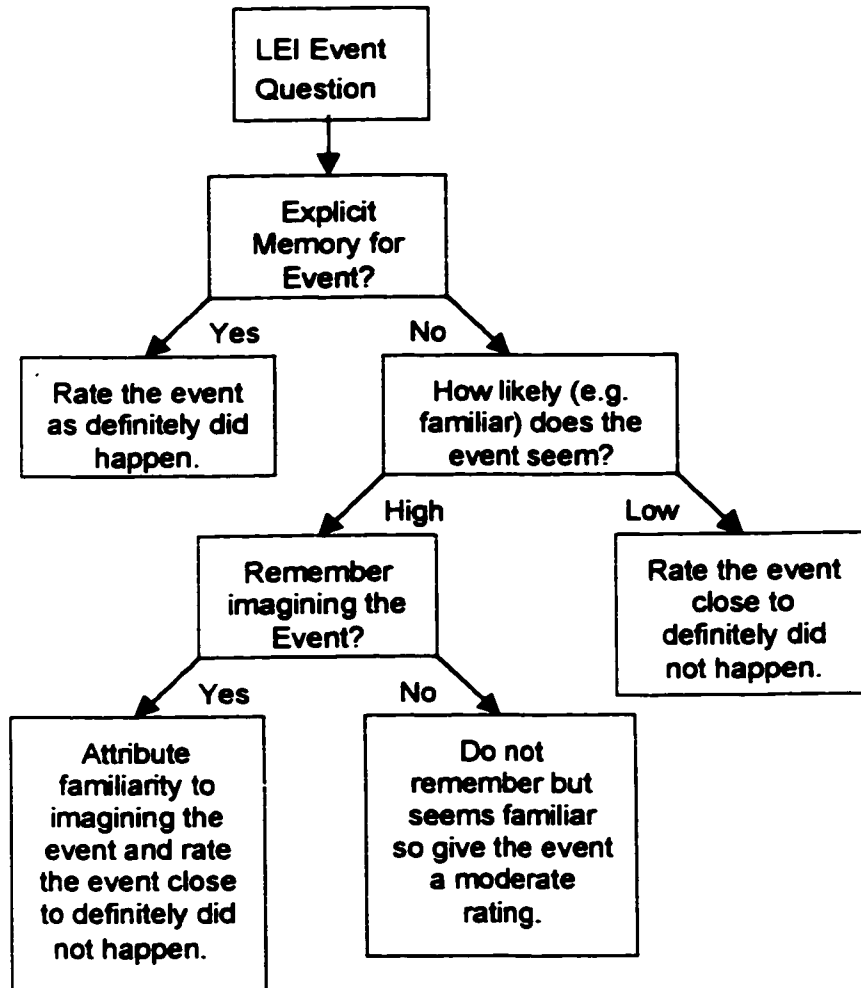


Figure 1: A familiarity-attribution model for answering the LEI

Predictions of the Model

In the familiarity-attribution model suggested by Jacoby and Whitehouse (1989) and outlined above, imagination inflation depends on the subject's ability to attribute any familiarity generated from imagination to the imagination session.

Attributing familiarity to imagining the event will work against imagination inflation. If that is the case then conditions that work against making that attribution should increase imagination inflation. Memory of the imagination session is necessary for making that attribution. Increasing the time between the imagination session and the posttest LEI should decrease memory for what was imagined and subsequently the ability of subjects to attribute familiarity to imagination (Loftus, 1998). However, we should also expect the additional familiarity created by the imagination to decay with time. Figure 2 shows the predicted relationship between decay of memory for imagination, the decay of familiarity and the resultant magnitude of imagination inflation as predicted by this model. Initially familiarity is high but so is the memory for the imagination activity so the familiarity can be attributed to the imagination activity. As time goes by familiarity decreases slowly but the ability to recall what was imagined decreases at a faster rate thus imagination inflation increases. Eventually familiarity with the event fades and the imagination inflation effect correspondingly declines.

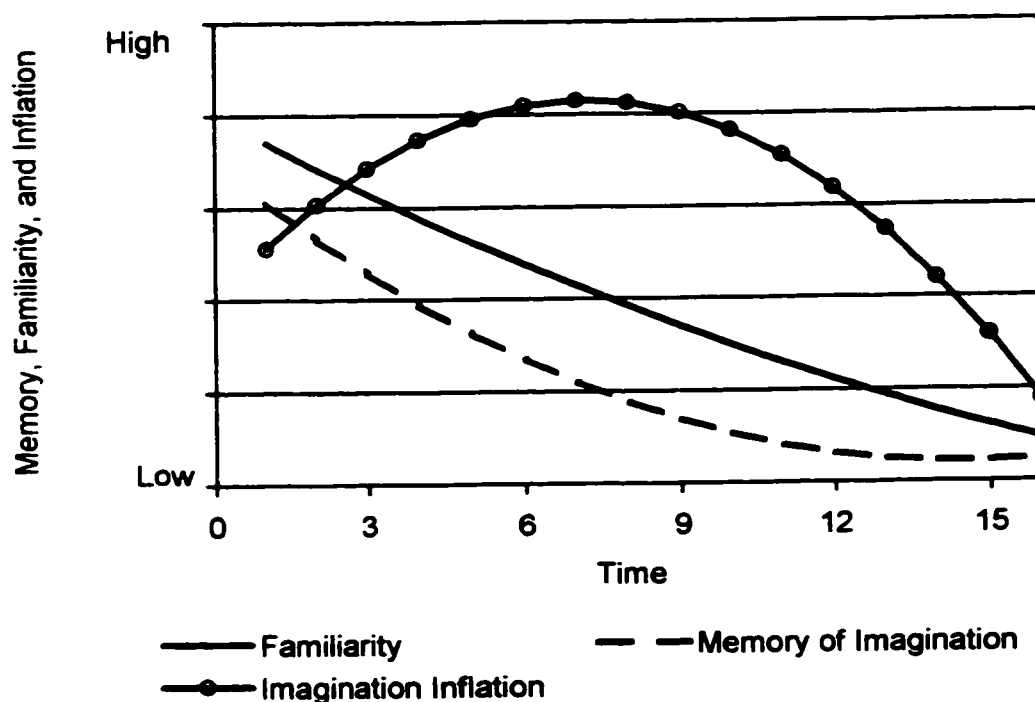


Figure 2: Predicted Imagination Inflation as a Function of Recall and Familiarity.

There is a bit of data to support this model. Marcos Nunes-Ueno administered the posttest LEI immediately, 1 week, or 2 weeks after the imagination task (for a brief discussion of this study see Loftus, 1998). The difference between the percent of imagined events increasing and the percent of not-imagined events increasing was used as an index of inflation. As can be seen in Figure 3, when the posttest was given immediately after the events were imagined, slightly fewer of the imagined events (31%) increased than the not-imagined events (33%) so there was no inflation (-2% inflation measure). However, when the posttest was delayed one week almost twice as many imagined events were increasing (40%) than not-imagined events (23%) producing an inflation measure of 17%. In the 2-week condition the inflation

score had decreased to a 10% difference (37% imagined versus 27% not imagined). This pattern fits with the prediction that immediately after imagining the event any familiarity produced by imagination could be attributed to the imagination activity so there would be relatively low inflation in the LEI rating due to imagination. After 1 week familiarity should still be high while the memory of what was imagined would be less available reducing the ability to attribute familiarity to imagination. High familiarity with a reduced memory for imagined events should produce relatively high inflation. Then at two weeks familiarity with the event should begin to fade and its inflationary effects would be reduced.

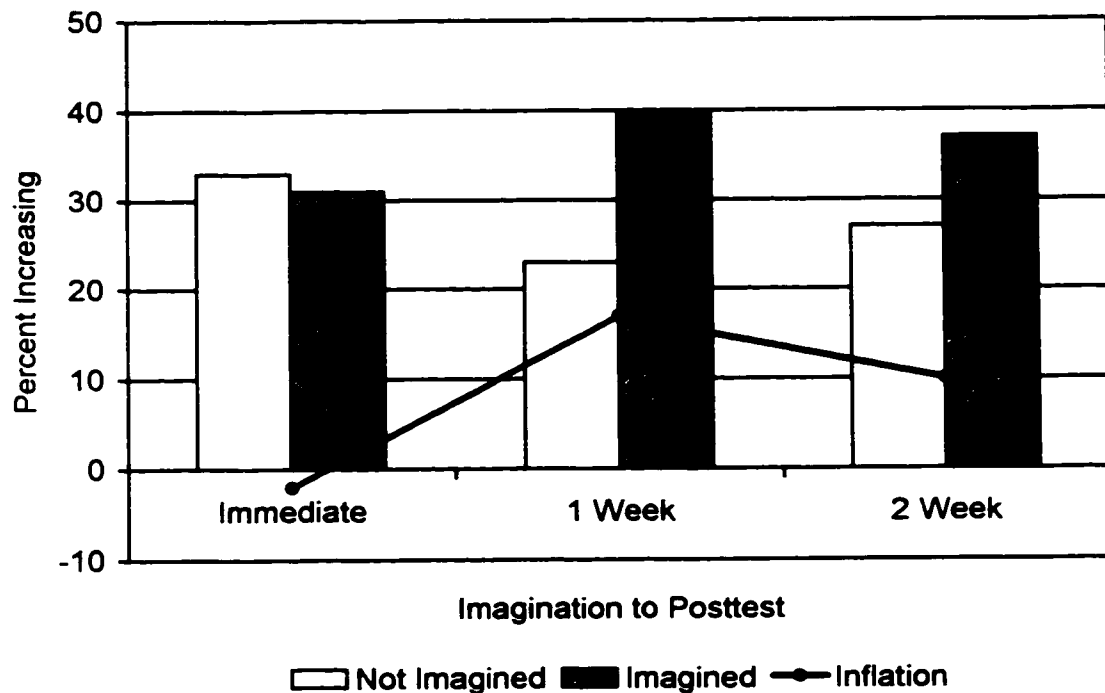


Figure 3: Percent of Events Increasing by Imagination and Delay from Loftus

(1998)

While the trends in the Nunes-Ueno data fit well with the model there are some problems assessing the reliability of the data. First, the immediate condition did not produce a reliable inflation effect. While not finding an effect for imagination immediately after the imagination exercise is consistent with the familiarity-attribution model outlined above it is not consistent with previous findings. Many of the studies which produced imagination inflation did so with a posttest that immediately followed the imagination session (e.g., Garry et al., 1996; Paddock et al., 1998; Paddock, 1999; and Heaps & Nash, 1999). This failure to produce an effect in the immediate condition could be due to sampling error or to some unique feature of the experiment. We rely on replication to take care of sampling error problems and a conceptual replication of the Nunes-Ueno study is reported below. If a unique feature of Nunes-Ueno study were reducing the effect then we would want to know how that feature was affecting the other delay conditions (i.e., the 1-week and 2-week conditions). Secondly, the sample size is small making the reliability of the data somewhat questionable, and certainly worth replication.

In order to overcome these shortcomings a study similar to the Nunes-Ueno study was conducted with the time between the imagination activity and the posttest varying from less than a day to two weeks. In this study subjects were administered the pretest LEI via the World Wide Web. Later they completed an in person imagination session and rated their images on a several characteristics. Unlike in previous studies (Manning et al., 2000), images characteristics were judged immediately after the imagination activity instead of after a delay. This was done so the ratings would reflect the characteristics of the image as it was imagined instead of the memory of what was imaged. Subjects were asked to complete the posttest LEI

either by the end of the following day, one week later, or two weeks later. Like the pretest, the posttest was administered over the World Wide Web. In order to assess subjects' memories for what they imagined a recall questionnaire was included after the posttest LEI.

Data were collected over the World Wide Web for a number of reasons. Collecting data this way allows for some efficiencies. Using the web can cut down the drop-out rate by making participation more convenient because subjects do not need to come to the lab to sign up for the experiment, to complete the pretest, or to complete the posttest. Having an automated system for sending reminders to subjects for both their on-line appointments and their in-person appointment can also reduce the dropout rate. Collecting data this way is also more convenient for the experimenter because subjects do not need to be met, questionnaires do not need to be handed out and collected, and the data do not need to be transferred from paper to a computer database. By using a computer to collect the data the data can be checked for completeness so that subjects do not miss items or choose two responses (e.g., check both 1 and 5 in response to a single LEI event) when only one is desired.

Beyond the practical reasons there are some other reasons for using the World Wide Web. Having subjects complete the pretest and the posttest in a setting other than the psychology lab may have some advantages. Subjects completing the LEI in a setting such as their home or the library may treat the LEI differently than they would if they completed it in the psychology lab. Thus finding an imagination inflation effect when the LEI is presented outside the lab adds to the generalizability of the findings. Another advantage is having the posttest taken in a different context than the imagination activity should make the connection between the two activities

less obvious. This should also reduce environmental retrieval cues for the imagination activity. In previous experiments (e.g. Garry et al., 1996 and Manning, et al., 2000) the LEI was arranged with the events listed on the left side of the page and the response scale (the digits 1 to 8) on the right side. Because the most common response to most LEI events was a "1" subjects may have developed a response set. That is after circling "1" for a number of events they may have adopted the strategy of moving their pen or pencil down the page so that it would be in position to circle "1" for the next event. However with the web based LEI, events can be presented one at a time so subjects could not see a pattern in their responses by simply looking at the page. Also, after choosing the rating for an event subjects would need to move their pointer (e.g. mouse) in order to submit their answer and see the next question. Because the pointer has to be moved after each rating no one rating is physically easier to choose than other ratings and that should help reduce any bias due to the subject developing a response set.

Methods

Subjects

Participants were recruited from students enrolled in introductory psychology courses at the University of Washington. Fliers informing the students they could receive extra credit by participating were distributed in the classes. The flier described the basic procedures of the study and gave the World Wide Web address that students would need to access in order to participate. All subjects were required to have access to the Internet and an email address, both of which are provided to all students at the University. A total of 304 signed up for the study and 276 completed all phases on time.

Materials

The Life Events Inventory (LEI) was administered over the Internet using Hypertext Markup Language (HTML) forms, which could be accessed using a standard web browser. The LEI consisted of 40 questions (see appendix A). Each question asked participants to indicate how confident they were that an event did or did not happen to them before they were 10 years old. Participants indicated their confidence by selecting one of 8 buttons. The buttons were anchored with "Definitely did not happen" above the far-left button and "Definitely did happen" above the far-right button (see appendix B). LEI questions number 7, 9, 10, 13, 16, 20, 25, and 28 were critical events and are listed in Table 1. The order of LEI questions was the same for all subjects. A complete list of LEI items is given in appendix A.

Packets for the imagination sessions consisted of a cover page with instructions followed by four pages, one for each of the to-be-imagined events. The final page of the packet was a filler activity. The instructions for the imagination tasks were as follows:

Please try to imagine a scenario that includes the target event. We are interested in how completely and realistically you can imagine the target event. Make your image as complete, vivid, and realistic as possible. To create an image that is more complete, vivid, and real it is often helpful to include particulars such as people, places, and things from your own life. Think about the details but don't force them, let the mental picture develop in a free flowing manner. After you have spent some time thinking about and imagining the event you will be asked to answer a few questions.

The participants were also told not to worry about spelling or grammar but rather to write a free flowing description of what they imagined and that some questions would be provided to help them describe their images (see appendix C). Each to-be-imagined event appeared at the top of a page with the following questions below "Who was involved?", "Where did it happen?", "When did it happen?", "What were the most noticeable details of your image?", and "What were the major events?" The questions were evenly spaced on the page.

The Memory Characteristics Questionnaire (MCQ, modeled after Johnson, Foley, Suengas, & Raye, 1988) asked subjects to rate six characteristics of the events they imagined on 7 point Likert-type scale. The characteristics were as follows: visual details (1 = little/none; 7 = a lot), feelings while imagining (1 = not intense; 7 = very intense), settings imagined (1 = unfamiliar; 7 = familiar), overall tone of the image (1 = negative; 7 = positive), sounds (1 = little; 7 = a lot), and smells (1 = little; 7 = a lot).

The recall questionnaire was administered using HTML forms over the Internet. At the top of the recall questionnaire were these instructions.

Next we would like you, if you can, to recall the events you imagined during the imagination session. Below are four boxes, one for each of the events you imagined. Place a description of each of the events you imagined in one of the boxes. Order is not important but you should type something in each box. If you can not recall one or more of the events you imagined then type "Do not remember" in the box.

Design

The design was a 2 (imagination) X 3 (delay) mixed design. The within-subject factor was whether the events were imagined or not imagined. Eight of the events that appeared on the LEI were critical events (see Table 1). These eight events were split in two sets, set A and set B. Each participant imagined one set of events and the other set served as controls (not-imagined). The between-subject factor was the imagination-posttest delay. Subjects assigned to the 1-Day delay condition were asked to take the posttest the same day as the imagination session or the day after the imagination session. Subjects assigned to the 7-Day and 14-Day conditions were asked to complete the posttest any time during the assigned day (either 7 or 14 days after the imagination session).

Procedures

There were three activities in this study, the pretest, the imagination session, and the posttest. Before participating in any of the three activities subjects logged on to the web site and signed up to participate. The on-line sign-up form ask subjects to submit identifying information necessary to receive credit for participation, an e-mail address to send reminders to, a date a time to participate in the imagination sessions, and to choose a password. All personal information was transmitted to and from the web server using a Secure Socket Layer (SSL; see Graham, 1997) to insure privacy. And, LEI data sent from the subject's computer was transmitted using the "POST" method (see Graham, 1997) this prevented subjects from returning to previous answers or seeing the data codes in the location field of their browser. After completing the sign-up form subjects were given a code number and all remaining

communications with the web server were completed using only the subject's code number and password.

Subjects were requested to complete the first activity (the pretest) immediately after they signed up however they could complete the first activity any time up to two days before the second activity (the imagination session). The first activity consisted solely of the pretest. In order to log on and take the pretest subjects entered their code numbers and passwords. After the subject logged on the instructions and the first LEI item were presented (see appendix B). After selecting their answer the subjects clicked on button labeled "next question" and the next LEI item appeared while the instructions remained on the screen. The same item would be presented again if subjects failed to choose one of the eight buttons. Upon completing the 40 LEI questions subjects were reminded of the date, time, and location of session two and were thanked for completing the first session. The times subjects began the pretest and the times they finished were recorded.

Session two was the imagination session and subjects participated in person. Two to seven participants attended each imagination session. All participants in each imagination session imagined the same set of events (set A or B). Upon arriving for the imagination session the experimenter gave each participant a copy of the MCQ and an imagination packet. The experimenter read aloud the instructions printed on the first page of the imagination packet and asked if there were any questions. Subjects were then asked to turn to the next page of the packet, the experimenter read the to-be-imagined event aloud (e.g. "Imagine finding a \$10 bill in a parking lot before you were 10 years old."), and then subjects were given time to imagine that event. Participants were given four minutes to imagine and write about that event.

Immediately after imagining the event subjects were asked to turn to the MCQ and complete it. After all subjects complete the MCQ the experimenter asked them to turn to the next page. The same steps were repeated for each of the four events. After imagining the fourth event subjects were asked to complete the filler activity while the experimenter assigned them to delay conditions and printed reminder notices. Subjects were randomly assigned to an imagination-posttest delay condition. Participants were then thanked for their participation in the imagination activity, told what day they should log on the web site and complete the third activity (posttest), and given a reminder slip.

The day before the third activity (the posttest) each subject was sent an email reminding him or her of the web address and when to log on for the third activity. Subjects could complete the posttest any time on the assigned date. The posttest was exactly the same as the pretest up until the subjects completed the last LEI item. After the last LEI item subjects were given the recall questionnaire. Subjects were asked to type something in each of the four boxes. If one of the boxes was left blank, the recall questionnaire was presented again. After completing the recall questionnaire subjects were sent a debriefing statement, thanked for their participation, and given information related to their receiving credit for participating. The time each subject began and finished to posttest was recorded.

Table 1: Distribution of pretest scores for the critical events.

Question Number and event	Pretest Rating								Mean	Median
	1	2	3	4	5	6	7	8		
7. found a \$10 bill in a parking lot.										
Not-imagined	40	23	15	25	11	6	6	5	3.08	3
Imagined	42	19	17	31	14	12	2	8	3.28	3
9. got in trouble for calling 911.										
Not-imagined	99	14	5	1	0	7	6	13	2.30	1
Imagined	82	16	2	5	5	4	2	15	2.47	1
10. had to go to the emergency room late at night.										
Not-imagined	31	7	10	4	8	9	8	54	5.14	6
Imagined	42	6	16	3	12	8	10	48	4.67	5
13. had a lifeguard pull you out of the water.										
Not-imagined	74	23	13	10	8	8	1	8	2.47	1
Imagined	64	30	13	9	3	3	3	6	2.30	2
16. gave someone a hair cut.										
Not-imagined	62	21	11	13	8	6	6	18	3.11	2
Imagined	62	15	14	7	3	5	4	21	3.08	2
20. broke a window with your hand.										
Not-imagined	100	15	5	3	4	0	0	4	1.60	1
Imagined	115	14	4	5	1	1	1	4	1.55	1
25. saw a major league ball game.										
Not-imagined	46	7	1	5	1	9	10	52	4.79	6
Imagined	51	6	9	4	5	9	10	51	4.57	5
28. won a stuffed animal at a carnival game.										
Not-imagined	22	9	10	13	15	23	19	34	5.10	6
Imagined	20	6	9	7	11	24	20	34	5.33	6

Results

Delays

Recall the subjects were assigned to take the posttest either the same day as the imagination session, the following day, one week, or two weeks later. For purposes of analysis subjects who took the posttest the same day or the next day are included in the 1-Day condition. Subjects in the 1-Day condition took the posttest between 0.022 days (32 minutes) and 1.55 days (37.2 hours) after the imagination session with the average delay of 0.65 days (15.6 hours). For subjects in the 7-Day condition the delays ranged from 6.37 days to 7.59 days with average of 7.06 days. And delays for subjects in the 14-Day condition ranged from 13.4 days to 14.6 days with an average of delay of 14.06 days.

Direction of Change

Garry et al. (1996) showed imagination inflation by looking at the direction of change in the LEI ratings from pretest to posttest. The question here is did the episode get a lower rating on the posttest than the pretest (decrease), the same rating (same), or a higher rating (increase). The percent of events decreasing, staying the same, and increasing for imagined and not-imagined events was computed for each subject.

The top panel of Figure 4 shows which directions events were changing after 1 day. As can be seen in that panel about half of both the imagined and not-imagined events (50% for both conditions) were given the same rating on the posttest as they were on the pretest. We can also see that fewer events decreased (24% of the not imagined and 19% of the imagined) than increased or stayed the same. However the

comparison of interest is the comparison between the number of events increasing in the imagined and the not-imagined conditions. That is did more imagined events show increases than not-imagined events? To answer that question the percent of imagined and not imagined events increasing for each subject was computed. One day after the imagination session slightly more imagined events ($M = 30\%$) were increasing compared to the not-imagined events ($M = 26\%$), however this difference was not significant, $t(136) = 1.55$, $p > .05$.

Seven days after the imagination session the overall pattern was the same, as can be seen in the middle panel of Figure 4. Again the most common response was to give the same rating on the posttest as on the pretest (60% for not-imagined events and 50% for imagined events). The least common response was to give a lower rating on the posttest than the pretest (15% for not imagined and 16% for imagined). However, after 7 days the difference between imagined and not-imagined events was larger than it had been after 1 day. After 7 days an average of 34% of the imagined events were showing inflation while only 25% of the not-imagined events were showing inflation. This difference was significant, $t(66) = 3.69$, $p < .02$.

Finally, 14 days after the imagination session a similar pattern occurred as can be seen in the lower panel of Figure 4. The LEI ratings for most events did not change (58% for not imagined and 53% for imagined). Only a few LEI ratings decreased (20% for not imagined and 13% for imagined). At 14 days, the gap between the imagined and not-imagined events was even larger with an average of 34% of the imagined events increasing and an average of only 22% of the not-imagined events increasing. Once again the difference was significant, $t(71) = 3.69$, $p < .001$.

In sum an imagination inflation effect as measured by the difference between the number of imagined and not-imagined events increasing was small (a 4% difference) and not significant at 1 day, slightly larger (9%) and significant after 7 days, and largest (12%) after 14 days. In order to determine whether these increases in the imagination inflation effect were significant over the imagination-posttest delays, a 2 (Imagination: Imagined or not) x 3 (Delay: 1, 7, or 14 Days) Analysis of Variance (ANOVA) was done on the percent of events that increased. Collapsed over delay conditions, more imagined episodes than not-imagined events increased, $F(1,273) = 19.6, p < .001$. However, although there seems to be a trend for the difference between imagined and not-imagined episodes to increase with increasing delays, an interaction between delay and imagination was not found, $F(1,273) = 1.83, ns$.

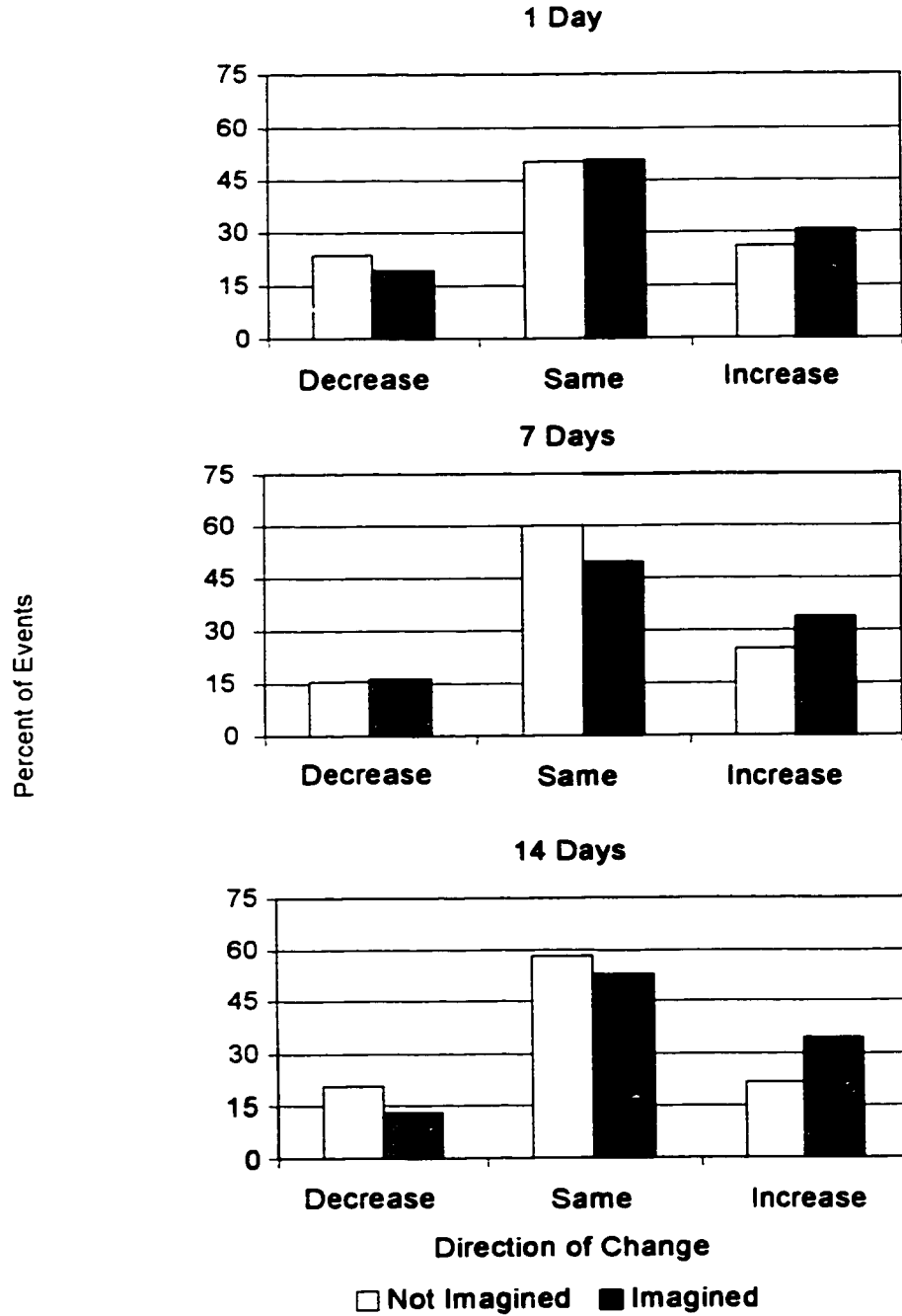


Figure 4: Percent of events Decreasing, staying the Same, and Increasing for each imagination-posttest delay.

Average Inflation

A different way to look at imagination inflation is to look at the amount of change from the pretest to the posttest. For each subject a mean change score was computed for the four imagined and the four not-imagined events. These mean-change scores can be seen by looking at the bars in Figure 5. The shaded bars in Figure 5 show the mean change for imagined events. As can be seen, the mean change for imagined events is almost identical in the 1-Day ($M = .38$, $SE = .099$) and 7-Day conditions ($M = .38$, $SE = .142$) but is much larger in the 14-Day condition ($M = .64$, $SE = .137$). There is a small but insignificant difference between 1-Day ($M = 1.0$, $SE = .071$) and 7-Day ($M = .23$, $SE = .102$) conditions for not-imagined events, and virtually no change for the not-imagined events in the 14-Day condition ($M = -.04$, $SE = .098$).

At first it might seem that a repeated measure analysis on the pretest and posttest ratings is appropriate for this data set but in fact an analysis of change scores is the same as a repeated measures analysis (see Maxwell & Howard, 1981) and will be used here. To that end, a 2 (imagined or not) x 3 (1, 7, or 14 days) ANOVA on the mean change scores showed there was a significant effect for imagination, $F(1,273) = 20.2$, $p < .001$. That is, on average both imagined events and not-imagined events tended to show inflation but over all imagined events showed more inflation than not-imagined events. This finding is consistent with the direction of change analysis. However, unlike the direction analysis, analysis of the change scores revealed a significant interaction between delay and imagination, $F(2, 273) = 3.4$, $p < .05$. So with this analysis, unlike with the direction of change analysis,

the delay between the imagination session and the posttest influenced the amount of inflation. There was no main effect for the delay, $F(2,273) = .23$, *ns*.

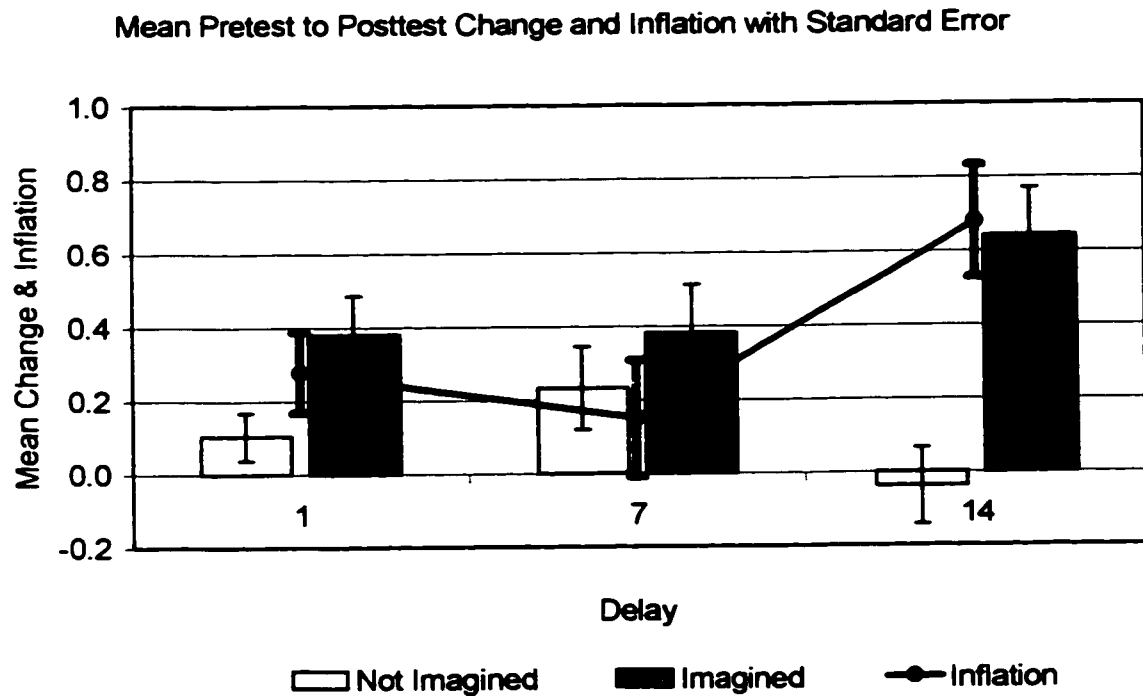


Figure 5: Mean Pretest to Posttest Change and Inflation (+SE) in each delay.

To further investigate how the relationship between the posttest delay and inflation, an inflation score was computed by taking the difference between the change scores for imagined and not-imagined events. This inflation score is represented in Figure 5 as a solid line. An omnibus test for difference in the inflation score would be the same as the test for an interaction in the change score so it was not calculated (see Maxwell & Howard, 1981). Instead t-tests were used to compare the inflation scores across the delays. Inflation scores 1 day after the imagining the

events ($M = .277$, $SD = 1.30$) were not significantly higher than after 7 days ($M = .150$, $SD = 1.30$), $t(202) = .66$, *ns*. However inflation scores increased significantly from 7 days to 14 days ($M = .681$, $SD = 1.29$), $t(137) = 2.42$, $p < .02$.

Size of Change

The mean change scores discussed above tell us that, on average, the rating given on the posttest is less than one point on the LEI scale different from the rating given on the pretest. It is worth noting that for about half of the events in every condition subjects gave the event the same LEI rating on the posttest as the did on the pretest (see Figure 4). This means that averaged in to those mean change scores (and inflation scores) are a lot of zeros. It would be interesting to know how much people change when they do change. Are there big changes in the LEI ratings of a few events or are lots of events changing a small amount? To answer this question a distribution of change scores is presented in Figure 6. In Figure 6 the change scores were collapsed across the delay conditions and then the percent of events for each possible change score (e.g., a -7 would represent a change from 8, "definitely did happen" to 1, "definitely did not happen") were computed. The distribution of change scores in Figure 6 shows once again that most events did not change and that when posttest LEI ratings were different from pretest ratings they were usually only different by a point or two. It is interesting to note that there were more imagined than not-imagined events for each of the positive change scores. Figure 6 also shows that large changes in LEI ratings, say from a 1 (definitely did not happen) to an 8 (definitely did happen) resulting in a change score of 7, are exceedingly rare.

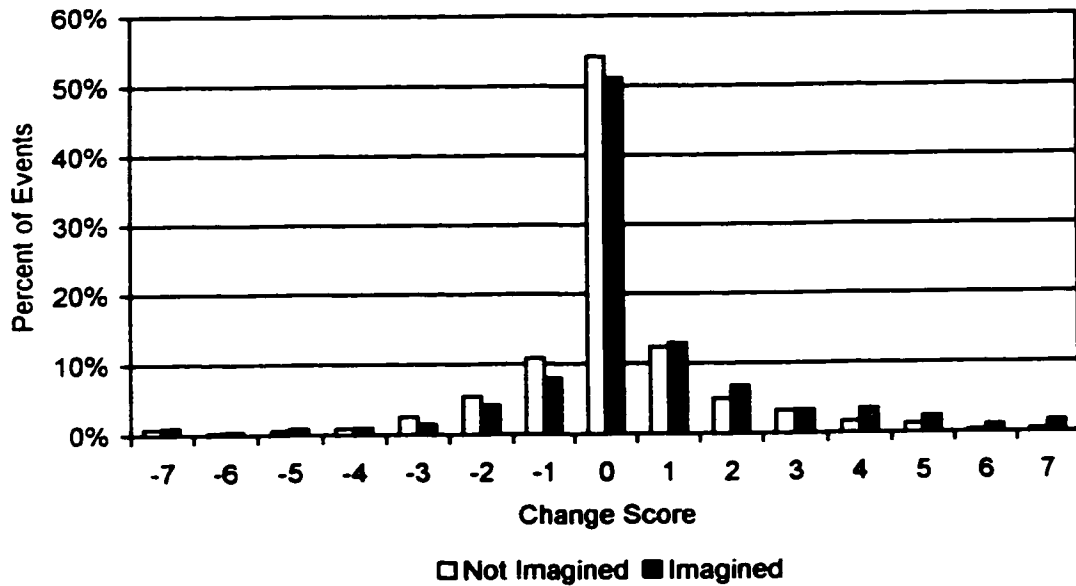


Figure 6: The distribution of change scores for imagined and not-imagined events collapsed across delay conditions.

As has been noted large changes in LEI scores were rare. However they did occur and this raises the questions of how often did they occur in each of the delay conditions. To address this the percent of events that jumped up 4 or more points on the posttest was computed. These "big jumpers" are events that showed a great deal of inflation. They showed a great deal of inflation because in order to increase four points on an eight point scale, they must have started out with a pretest score of 4 or less and ended up with a posttest score of 5 or more. That is they started out with a LEI rating closer to "definitely did not happen" anchor and ended up closer to "definitely did happen" anchor. The percent of big jumpers for imagined and not-imagined events in each delay condition are shown in Table 2. In Table 2 it can be seen that big jumpers are rarest when events were not-imagined (< 5%). Imagination

produced a relatively larger percent of big jumpers with the largest number of big jumpers (11.5%) being seen after a 14 day delay. So, while a sizable proportion of the events showed big jumps the majority showed much smaller changes in confidence.

Table 2: Events showing a change score of 4 or more by imagination and delay.

	Delay			Mean
	1-Day	7-Day	14-Day	
Not-imagined	3.28%	4.85%	3.82%	3.80%
Imagined	8.39%	8.21%	11.46%	9.15%

Recall and Imagination

After subjects had completed the posttest they were asked to recall what they had imagined earlier. The answers to those free recall questions were coded as having recalled the event or not. Due to the inability of some web browsers to send large strings of text, 16 subjects were unable to complete the recall test so data from those subjects were not included in the following analyses. How often were subjects able to remember what they imagined? Figure 7 shows that as the delay between imagination and recall increased, the number of the imagined events remembered decreased. There was a significant drop in recall from the 1 day condition ($M = .81$, $SD = .274$) to the 7 day condition ($M = .66$, $SD = .296$), $t(187) = 3.53$, $p < .001$. However the drop from 7 to 14 days ($M = .62$, $SD = .321$) was not significant, $t(135) =$

.74, ns. It should be noted that even after 14 days subjects were recalling over 60 percent of events they had imagined.

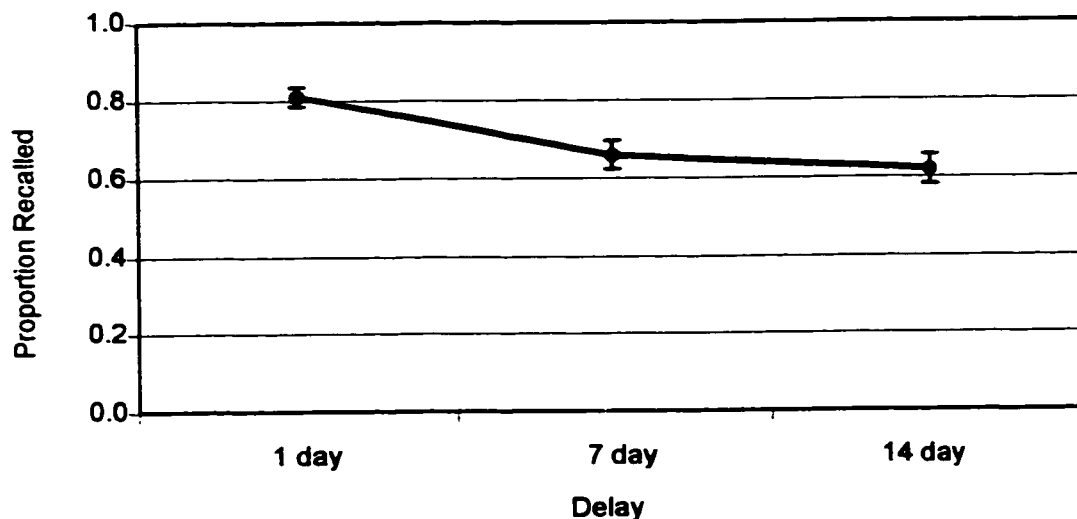


Figure 7: Mean Proportion Recalled (+SE) by delay.

Did the subject's memory of the imagination session influence imagination inflation? Just as there is more than one way to look at imagination inflation there is more than one way to answer that question. To do this the direction of change and recall was examined as was mean change and recall. To look at the direction of change and recall, the percent of recalled and forgotten events that increased was calculated (see Figure 8). The question here is whether subjects showed inflation as often when they remembered imagining events as when they did not remember. Figure 8, shows after one day a slightly higher percent of recalled events (32.1) were showing inflation than forgotten events (30.1). In the 7-Day condition the difference is in the same direction and a somewhat larger. After 7-Days 35.6% of the recalled

events showed inflation compared to 31.1% of the forgotten events. After 14 days not only did the trend reverse but the differences between forgotten and remembered events were largest. In the 14-Day delay fewer of the recalled events (30.7%) showed inflation than forgotten events (38.9%).

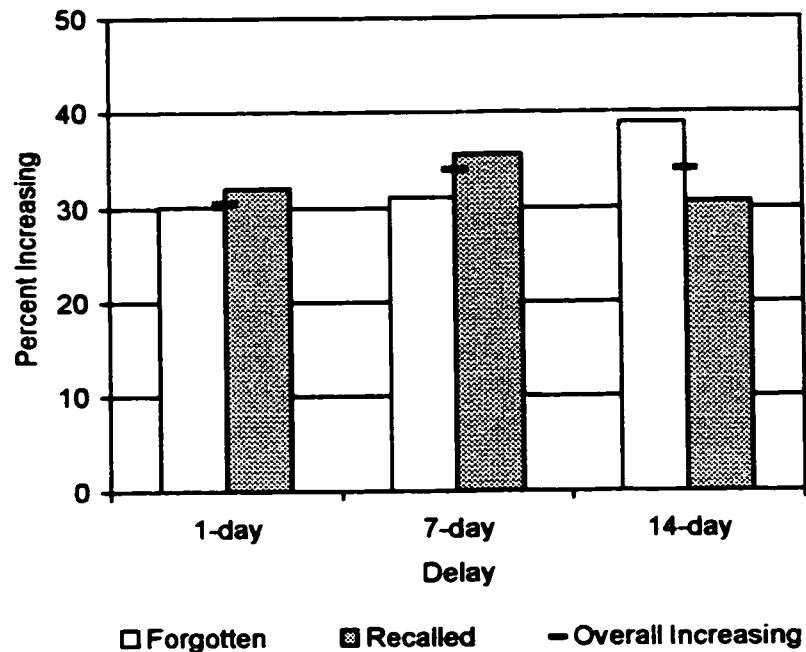


Figure 8: Percent of Recalled and Forgotten Events Increasing.

The mean change for forgotten and recalled events was also examined. Figure 9 shows the mean change for imagined and not-imagined events that were recalled and forgotten in each of the delay conditions. The most interesting feature of Figure 9 is that the mean change for the forgotten events seems to increase linearly with the delay. The mean change scores for the forgotten events are 0.19, 0.59, and 0.99 for the 1-Day, 7-Day, and 14-Day delay conditions, respectively. A regression showed there was a constant increase in the mean change for forgotten events over

the 3 delays ($\beta = .061$, $SE = .177$, $t(152) = 2.21$, $p < .05$). The mean change for recalled events does not seem to vary as much over the various delays. For recalled events the mean change scores were 0.43, 0.44, and 0.60 for the 1-Day, 7-Day, and 14-Day delay conditions respectively.

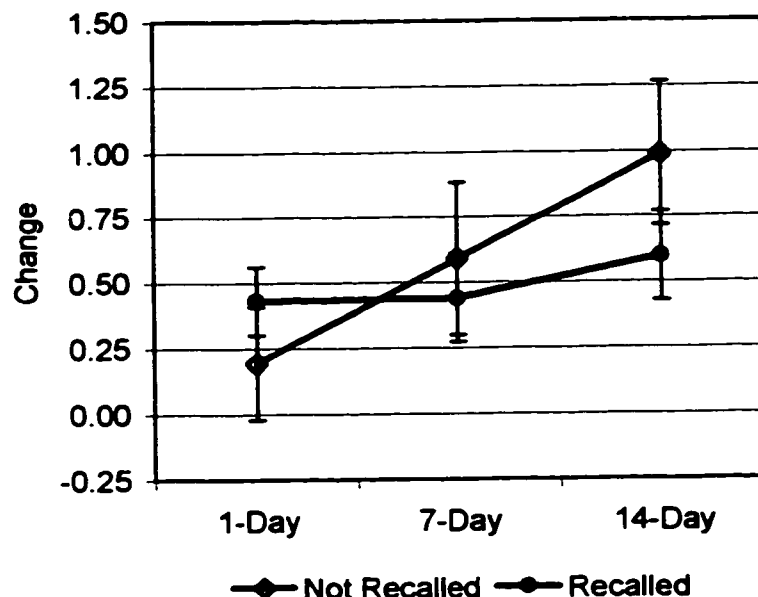


Figure 9: Mean Change (+SE) by Memory for the Imagined Event and Delay

The Memory Characteristics Questionnaire (MCQ)

Immediately after imagining each event subjects were asked to rate what they imagined on a six characteristics (visual details, feelings while imagining, settings imagined, overall tone of the image, sounds, and smells) using the MCQ. The first question to be addressed with these data is do more vividly imagined images produce more imagination inflation? To address this question the memory characteristics and the pretest LEI rating were regressed on the posttest rating for each of the imagined events. Backwards elimination was used to eliminate predictor variables (parameters

removed when $p < .10$) from the model and find the model that best predicts inflation for each event. Parameter estimates are presented in Table 3. First notice in Table 3 that the pretest was the best predictor of the posttest rating. This is not surprising given that for most events the pretest rating and the posttest rating were the same. The next thing to notice in Table 3 is that the MCQ items were not very good predictors of posttest scores. For each of the imagined events only one, two, or none of the MCQ items helped predict the posttest rating. However, the familiarity of the setting imagined was associated with higher posttest scores for three of the imagined events. That is the higher subjects rated the familiarity of the setting the higher their posttest ratings were.

The second question to address using the MCQ data is do those data predict whether or not the imagined event will be remembered. Again regression using backwards elimination was used to produce models for each of the imagined events (parameters removed when $p < .10$). The results of this analysis are presented in Table 4. As can be seen in Table 4, MCQ ratings were only useful at predicting recall for half of the events. And for those events there was no particular pattern in which MCQ items predicted recall.

Table 3: Regression models: predicting posttest ratings from pretest ratings, memory characteristics, and delay intervals for imagined events. Parameter estimates were removed from the model when $p > .10$.

Event	Predictor Variables							r^2
	Pretest	Visual	Setting	Feeling	Tone	Sound	Smell	
Found \$10	.451***	--	--	.195	--	--	--	.175
Hospital	.749***	--	--	--	--	--	--	.562
Ball Game	.696***	--	.235**	--	--	--	--	.598
Broke Window	.523***	--	.142*	--	--	--	--	.256
Called 911	.867***	.223*	--	--	--	--	.363	.639
Life Guard	.655***	--	.169	--	--	--	--	.329
Carnival	.516***	--	--	--	--	--	--	.289
Hair Cut	.681***	-.308*	--	.219*	--	--	--	.474

-- Parameter removed from model

* $p < .05$

** $p < .01$

*** $p < .001$

Table 4: Parameter estimates for regression models predicting recall using MCQ items. Parameter estimates were removed from the model when $p > .10$.

Event	Predictor Variables						r^2
	Visual	Setting	Feeling	Tone	Sound	Smell	
Found \$10	--	--	--	.052*	--	.058	0.057
Hospital	--	-.052*	--	--	.034	--	0.065
Ball Game	-.053	--	--	--	--	.039*	0.042
Broke Window	--	--	--	--	--	--	†
Called 911	.069	--	--	--	--	--	.055
Life Guard	--	--	--	--	--	--	†
Carnival	--	--	--	--	--	--	†
Hair Cut	--	--	--	--	--	--	†

-- Parameter removed from model

* $p < .05$

† $p > .10$ for all parameter estimates except the constant.

Discussion

Imagination Inflation was looked at over delays of 1 day, 7 days, and 14 days, and imagination inflation effect was found after each delay. The delay between the imagination task and the posttest did not significantly increase the number of events

showing inflation, however, after 14 days the increase in confidence for imagined events as compared to not-imagined events was larger than at the shorter delays. When the magnitude of change was taken in to account the amount of inflation 14 days after the imagination task was 2 or 3 times what it was 7 or fewer days after the imagination task.

The increased magnitude of the imagination inflation effect was associated with forgetting. After 14 days subjects were more likely to inflate on episodes they imagined than they were after 1 or 7 days. The magnitude of inflation seems to depend on whether or not subjects could remember imagining the event. When subjects remembered what they imagined the magnitude of inflation did not change noticeably over the three delays. But when subjects had forgotten what they imagined the amount of inflation increased with longer delays.

It was predicted that imagination inflation would increase over the first week and then decline. Looking at the direction-of-change analysis there is some evidence that imagination inflation increased over the first week however both the direction of change and the mean change analyses show that inflation continued to increase and did not decline as predicted. Does this mean the model was not supported? Not necessarily. The assumptions about the time frame may have been incorrect but the model itself still can serve as a good explanation of imagination inflation. Before discussing how the data fit the familiarity-attribution model some possible alternative explanations will be discussed.

Source Monitoring

Consider what the data would look like had subjects been making reality-monitoring errors. A reality monitoring error occurs when an imagined event is

ascribed to a real experience. In the case of imagination inflation a reality monitoring error would have occurred when a subject recalled what they imagined but mistook that memory for a real event. This might be a plausible explanation for why, after 14 days, more of the forgotten events are inflating than the remembered events. It is not that the memories for what was imagined would have decayed or been lost. Those memories would have still been there but the source of those memories would have been lost. So when those memories were retrieved they were attributed to real events instead of to the imagination exercises. Subjects may have "forgotten" what they imagined in the sense that they would no longer be attributing those memory traces to the proper source.

Where the source monitoring account of imagination inflation runs into trouble is with the size of the change scores. If, when attempting to remember an event, an image of that event can be retrieved and that image is attributed to a real experience then confidence that the event was experienced should be high. Similarly, if a subject were recalling an imagined episode and making a source monitoring error, mistaking it for a real event, we would expect that they would give that event a relatively high LEI rating, say 7 or 8. Because most imaged events show only small changes in the LEI scores (see Figure 6) it does not seem that the memories of imagination exercises were routinely mistaken for real events.

Also, it is not clear how the binary attribution (internally generated imagined event or externally experienced real event) of the source monitoring model would account for imagination inflation when subjects remember what they imagined. If they are recalling what they imagined and attributing it to imagination then they are

not making attributions errors. Yet the bulk of the events that show imagination inflation are events that subjects recalled imagining.

Imagination as a retrieval cue

One of the big problems with this sort of research is we do not know what really happened, we cannot manipulate the past to control for what events subjects may or may not have experienced. It is possible that some subjects experienced events similar to the events in the imagination task but have forgotten them. Could it be that the imagination task is merely serving as a cue for memories of real events? While it might be true for some subjects that the imagination activity served as a retrieval cue for memories of actual events this explanation does not fit the patterns in the data. The first argument against a retrieval cue explanation is similar to the argument against source monitoring errors. If subjects were recalling an event and rightly or wrongly attributing that memory to a real-life event we would expect a high rating on the posttest LEI. Again, the majority of events that are inflating are only inflating a few points on the LEI and are not making a big jump to "definitely did happen."

Another pattern in the data that argues against the retrieval cue explanation is the increase in inflation that occurs with longer delays. One would expect a cue to have greater effect when the time between the cue and retrieval is short. If the imagination activities were helping subjects recall events from their childhood when answering the posttest questions then we would expect the greater in inflation after 1 day than after 14 days, however the reverse was found.

Demand characteristics

The same patterns in the data that argue against recall-based explanations for imagination inflation also argue against an experimental-demand explanation. If subjects guessed that the hypothesis of the experiment was that imagination would cause increased confidence, then it would be reasonable to expect subjects to please the experimenter by showing larger changes than just 1 or 2 points. It would also be reasonable to assume that influence of demand would be greater the shorter the delay between the experimental manipulation (imagination) and the final measure (the posttest). In that case greater amounts of inflation would be seen for the shorter delays not the longer delays. Also we would expect greater amounts of inflation for events subjects remembered they imagined as opposed to those they forgot. The data were not compatible with either of those predictions.

Familiarity attribution

Originally the curve relating Imagination Inflation to time was predicted to be an inverted U-shape. This curve was predicted because it was thought that the more familiar an event is the more likely it would have been judged to have happened to the person. That is familiarity would increase confidence that the event had occurred. Acting against the influence of familiarity would be the ability to attribute familiarity to the imagination activity. Subjects who found an event familiar would be less likely to show high confidence that it happened when they remembered they had imagined the event than when they did not remember imagining it. Soon after imagining the event familiarity would be high but so would memory of imagining the event so the effect of imagination would be moderate. It was assumed that explicit memory for the imagined event would decrease at a faster rate than familiarity. So some time after

the imagination session subjects familiarity should be high relative to their ability to recall what they imagined and this would produce a high level of imagination inflation. At longer delays familiarity would decrease substantially so the imagination inflation effect would be reduced. The current data do not show this inverted-U trend over a 2-week period. The inflation scores at the intermediate delay (7 Days) were not found to be higher than inflation scores at a short delay (1-Day) and a large increase in inflation scores was seen between the intermediate delay and the longest delay (14 Days). This pattern does not invalidate the model however. It could be that 14 days is not a long enough delay to see a decrease in the effect.

Is it that longer delays will always produce larger amounts of inflation?

Intuitively it seems that at some time after imagination the confidence bending effect of imagination must wane and there is some evidence this is the case. Goff and Roediger (1998) studied imagination inflation for recently preformed actions. Their second experiment, had three parts: subjects preformed some actions (encoding session), imagined some actions they had performed and some they had not (imagination), and finally indicated which actions they had performed and which they had not (posttest). The delay between when subjects imagined the actions and when they took the posttest was varied so subjects imagined the actions either the same day as they took the posttest, 7 days before, or 14 days before¹. Goff and Roediger used false alarms (incorrectly saying an action had been preformed when it had not) as their measure of imagination inflation. In addition subjects imagined each action 1, 3, or 5 times. As can be seen in Figure 10, with the more involved

¹ Goff and Roediger (1998) used "Early" to indicate an action that was imagined 14 days before posttest, "Middle" for actions that were imagined 7 days before the posttest, and "Late" for actions that were imagined just before the posttest.

imagination manipulation of imagining an action 5 times, the proportion of false alarms increased with increasing delays (.06, .09, and .11 for immediate, 7 days, and 14 days respectively). When the actions were imagined three times the proportion of false alarms increased slightly from the immediate (.08) to the 7-Day (.09) condition and then decreased to .05. And, in the relatively less involved imagination condition when actions were only imagined once (subjects were given 12 seconds to imagine each action) the false alarm rates dropped from .09 immediately after imagination, to .06 after 7 days, and to .04 after 14 days. What can be drawn from the Goff and Roediger data is that longer delays may not always produce larger amounts of inflation. When the imagination was relatively less involved then the effect began to drop off after 7 days or less. When the imagination task required greater involvement then the effect began to decline some time between 7 and 14 days later. However, with the highest level of involvement in imagination there was no decline even after 14 days.

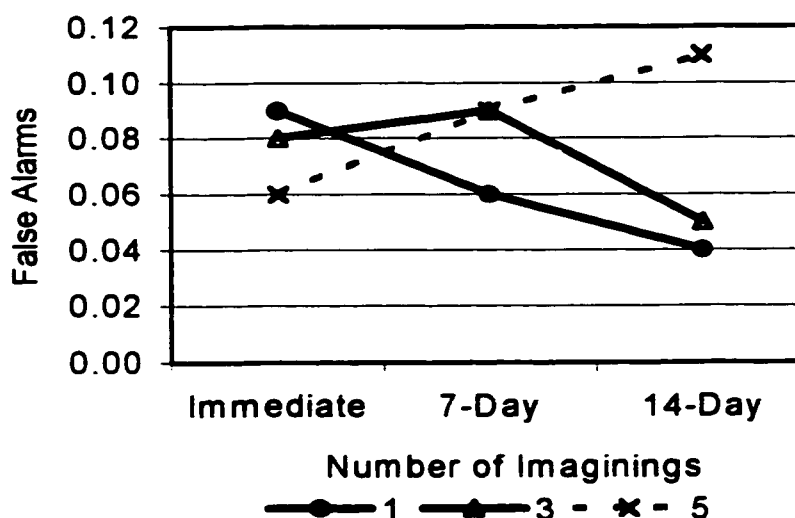


Figure 10: Inflation as measured by false alarm rates, data from Goff and Roediger (1998).

There is one important caveat to interpreting Goff & Roediger's (1998) data in this way. That is, the interval between the session in which actions were performed (encoding session) and the posttest was always 14 days. This means that as the interval between imagination and the posttest increased the interval between the encoding session and imagination decreased. As a result those two time intervals are confounded and we can not know whether changes in the dependent variable are due to encoding-imagination interval or the imagination-posttest interval.

Although caution should be used in interpreting the data in Figure 10 it should be noted that the patterns do fit with the familiarity attribution model. When an action was only imagined one brief time then that imagination activity should not be very memorable and it should only produce modest amounts of familiarity. According to the model, that modest amount of familiarity would initially produce some inflation

because the memory of the imagination activity, and thus the ability to attribute the familiarity to its source, would be low. However as time goes by the familiarity would fade and inflation would fade with it. With more powerful imagination activities (such as multiple imaginings) the level of familiarity would be high, as would the ability to attribute that familiarity to its source. In that case as time goes by the memory for what was imagined would fade taking with it the ability to attribute the familiarity to its source so inflation would increase. It did just that in this study and when Goff and Roediger (1998) had subjects imagine actions multiple times. And, as we can perhaps see in Goff and Roediger's three-repetition condition, the familiarity generated by more involved and powerful imaginations will also eventually fade sometime after the imagination activity has ceased and inflation will decrease.

It is interesting to consider what might happen when someone continues to imagine what might have been. Repeated rehearsal should boost and maintain familiarity. Rehearsal also aids memory however it may not aid memory for the activity of imagining. That is repeatedly imagining an event should increase the memory for what is imagined but may not increase episodic memory for each activity of imagining. Someone who repeatedly imagines finding \$10 in parking lot when they were a child, should have a good memory for the imagined parking lot and the \$10 bill but they may not be able to recall the first time they imagined it. The disassociation between episodic memory for the act of imagining and familiarity associated with the imaged event should produce ideal conditions for imagination inflation and the development of false memories.

Repeating the question, a weak form of Imagination?

Garry et al. (1996) argued that positive change, or "inflation," found with the not-imagined events might be due to repetition effects. That is just asking questions like "Did you find a \$10 bill in a parking lot?" may lead to a small increase in familiarity and thus lead to inflation. This small increase in familiarity may lead to slight increases in confidence on the posttest. This could explain the inflation rates for the not-imagined events. There is a trend (not significant) for fewer not-imagined events to increase as the delay between imagination and the posttest increases (see Figure 4). The trend is not as consistent for the change scores of not-imagined events (see Figure 5). To investigate this further the delay between the pretest and posttest was investigated. The mean pretest-imagination delays were 13.0 ($SD = 8.1$), 12.8 ($SD = 7.8$), 13.4 ($SD = 6.6$) days for the 1-Day, 7-Day, and 14-Day conditions respectively. Across the conditions the average the delay between pretest and imagination was 13.1 ($SD = 7.6$) days. Now consider the change scores for the not-imagined events (see Figure 5). In the 1-Day (an average of 14 days after the pretest) the mean change for not-imagined events is slightly greater than zero ($M = .10$, $SE = .064$). In the 7-Day (20 days after the pretest) condition the mean is slightly (but not significantly) higher ($M = .23$, $SE = .113$). However, after 27 days (the 14-Day condition) the mean change for the not-imagined events has decreased and is close to zero ($M = -0.04$, $SE = .104$). This pattern fits with the U-shaped curve predicted by the model. So, it could be that after 27 days any familiarity generated by the pretest began to fade and the thus LEI ratings returned to their original levels. The amount of familiarity generated by simply completing the LEI should be relatively small compared to the familiarity generated by imagining the event. If the relatively

small effect does not begin to fade until 27 days after the question then it is not surprising that the stronger imagination task employed in this experiment did not begin to fade after only 14 days.

Conclusions, future research, and implications

This study replicated the imagination inflation effect in that one simple four-minute imagination activity caused subjects to increase their confidence that an event happened to them. Confidence that the event happened to them continued to rise over the 2 weeks after the imagination activity. This fits with a familiarity-attribution model of false recognition (Jacoby & Whitehouse, 1989). That model also predicts imagination inflation will not last forever and will begin to wane at some point. There is weak evidence from the not-imagined events in this study and from a study of briefly imagined actions that the last prediction also holds. However, much better evidence is needed and it could come from a study in which the inflation due to imagination is measured at intervals longer than two weeks. How far in to the future those studies should look is not known, it could be months.

The familiarity-attribution model makes predictions based on familiarity and ability to remember its source. In this study memory for source was examined. When subjects did not recall what they had earlier imagined, inflation scores increased with time (see Figure 9). To see how this fits with the model consider that imagination will produce more memorable memory traces sometimes and less memorable traces other times. It is assumed that memorability and familiarity are related. The events that were forgotten early would, by definition, be low in memorability and therefore low in familiarity and the model predicts low inflation for those events. After two weeks the collection of forgotten events would include more memorable events that

would be higher in familiarity and therefore we would expect more inflation for those events. What is key to this explanation is that familiarity is related to memorability and to inflation. Future research could look at those relationships.

Finally, we should go back to the questions that initially generated this line of research. Questions were raised about the efficacy of using imagination to retrieve lost memories. Whether imagination can help retrieve a preexisting memory was not looked at but whether imagination could influence what we think might have happened to us was. The findings suggest that the use of imagery can affect what we think might have happened and possibly what we think did happen. We also learned that the effect of imagination is not short lived. The implication is that the use of imagery is suggestive and memories retrieved with the use of imagery should be considered skeptically. The ability to consider what might have been or what could be may be the attribute that sets humans apart from other animals. Imagery is one of the tools we use to think about the world and our place in it. It is a powerful instrument and like all things of power we should consider the myriad consequences of its use.

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Appendix A: Events on the Life Event Inventory

1. shook hands with The President.
2. received your first allowance.
3. had a shot at the doctors or dentist.
4. saw your house burn down.
5. ran away from home.
6. cried when you had to go to the dentist.
7. found a \$10 bill in a parking lot.
8. won a spelling contest at school.
9. got in trouble for calling 911.
10. had to go to the emergency room late at night.
11. were lost in a public place for more than an hour.
12. had a talk about where babies come from with a parent or guardian.
13. had a lifeguard pull you out of the water.
14. adopted a lost animal.
15. felt an earth quake.
16. gave someone a hair cut.
17. opened your own bank account.
18. were stuck in a tree and had to have someone help you down.
19. won a blue ribbon at the fair.
20. broke a window with your hand.
21. were thrown off a horse.
22. got caught sneaking out of the house late at night.
23. prepared a meal for your family.
24. had your house robbed.
25. saw a major league ball game.
26. smoked a cigarette.
27. had your best friend move away.
28. won a stuffed animal at a carnival game.
29. kissed your girlfriend/boyfriend at school.
30. fell off your tricycle and had to have stitches.
31. wore makeup for the first time.
32. saw a solar eclipse.
33. had a sip of an alcoholic beverage without your parents knowing.
34. went on a hot air balloon ride with classmates.
35. found some keys one of your parents had lost.
36. went on your first airplane ride.
37. saw an 'R' rated movie.
38. cheated on a test.
39. learned to ride a skateboard.
40. participated in a wedding.

Appendix B: Life Event Questionnaire

Life Event Questionnaire

Instructions

The following questions are about some events that may or may not have happened to you before you were 10 years old. For each event indicate how certain you are that the event (or a very similar event) did or did not happen to you by clicking on one of the buttons. Click on the far-left button only if you are completely confident that the event **did not** happen to you before you were 10 years old. Click on the far right button if you are completely confident that the event **did** happen to you before you were 10 years old. And, if you are not completely confident choose one of the middle buttons.

After you have made your selection click on the NEXT button to go to the next event. Do not use the Back button on your browser to return to a previous question.

	Definitely	Definitely
	did not	did
Before you were about 10 years old you..	happen	happen

...found a \$10 bill in a parking lot.

NEXT QUESTION

Appendix C: Examples of subjects' descriptions from the imagination activity

Note: Below are examples of subjects written responses to the imagination tasks. Each example was taken from a different subject. Subjects' responses are in *italics*.

Target event: Finding a \$10 bill in a parking lot.

Who was involved? *I was w/ my mom & sister. My sister is one year older than I [and] was jealous because she thought she should have found it.*

Where did it happen? *Outside of a grocery store after grocery shopping.*

When did it happen? *On a sunny day, when I was about 8 or 9.*

What were the most noticeable details of your image? *My mom pushing the grocery cart to the car and I walking behind my sister & mom. Looking on [the] ground.*

What were the major events? *Finding (seeing) the \$ on the ground, fighting with [my] sister about \$.*

Target event: Broke a window with your hand.

Who was involved? *My brother, my father, my 2 younger brothers' mother, and I.*

Where did it happen? *At an old farmhouse that we used to live in.*

When did it happen? *After school one day, probably directly following dinner.*

What were the most noticeable details of your image? *My brother surprised face, the old, dirty carpet, the smell of popcorn with butter & garlic.*

What were the major events? *My brother and I were pillow fighting and I accidentally [sic] put my hand through the window when he dodged my swing. My father seemed relaxed about the whole situation.*

Target event: Gave someone a hair cut.

Who was involved? *I, my sister.*

Where did it happen? *At home, in the bathroom*

When did it happen? *During the day when my mom is at work.*

What were the most noticeable details of your image? *My sis's horrible hair cut.*

What were the major events? *I tricked her into letting me give her a hair cut for 2 pieces of candies. After the hair cut, she happily walked away.*

Target event: Won a stuffed animal at a carnival game.

Who was involved? *Myself, my brother*

Where did it happen? *At the Puyallup fair.*

When did it happen? *When I was 8 or 9, fall.*

What were the most noticeable details of your image? *Sound of skee-balls going up the ramp, smells of food, at night + lots of bright flashy lights, rows of stuffed garfields at booth.*

What were the major events? *My brother + I were playing skee ball + I wanted to do better than him so I could win a better prize, I got a really high score + lots of my bass went in the 50pt ring, and I won a stuffed garfield, teased my brother, he got kind of mad.*

Target event: Went to a major league ball game.

Who was involved? *Me, my dad, my brother*

Where did it happen? *The kingdom, in the nose-bleed section.*

When did it happen? *When I was 7, on a school day, during the day.*

What were the most noticeable details of your image? *The three of us sitting near the top of the Kingdome on the uncomfortable table chairs, the ceiling, the field, the 'SEATTLE' emblem.*

What were the major events? *One pitch, and then the catcher catching it, and a second later the sound of the catcher catching it, and then we noticed that.*

Target event: Got in trouble for calling 911.

Who was involved? *My sister and I were fooling around with the phone and we called 911 and hung up the phone a couple of times.*

Where did it happen? *It happened at our Tacoma house when I was about 8 years old.*

When did it happen? *8 years old.*

What were the most noticeable details of your image? *The 911 department called the house back and knew it was a bunch of kids goofing off and the representative told us how dangerous it was to prank them and not to do it again.*

What were the major events? *My sisters and I laughing. Lecture from the representative that called us back.*

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