ENVIRONMENTAL CONTEXT EFFECTS IN AN IMPLICIT MEMORY MEASURE

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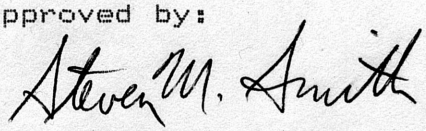

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CONSCIOUS AND UNCONSCIOUS EFFECTS OF ENVIRONMENTAL CONTEXT-DEPENDENT MEMORY. S.M. Smith, Texas A&M University, F.R. Heath, Stanford University.

ABSTRACT

Environmental Context effects refer to experimental findings that recall of learned material is better if it takes place in the original learning environment rather than in a changed physical environment. Eich (1985) demonstrated that the EC effect can be produced by a conscious memory strategy (method of loci), and has questioned whether the learning environment would become associated with a memory trace in the absence of such a conscious strategy. Ancedotal data, in contrast with Eich's explanation, indicate that at least in some situations EC effects can be found without the use of a conscious memory strategy. Explicit memory measures tap con- scious memory processes which may override effects of background context cues. A strategy-free test (i.e. implicit memory measure may better reveal unintentionally encoded contextual associations. In the present experiment, the EC effect was examined using a homophone spelling task which has often been used as an implicit memory measure (Eich, 1984; Jacoby & Witherspoon, 1982). EC effects were found with the implicit measure even when not present on an explicit recognition test. Implications for Eich's theory as well as Tulving's episodic/semantic distinction are discussed.

Most people have had the experience at some point in their life of breaking up with someone they have dated for a long time. One realizes very quickly during the recovery process that there are some places that are very bad to be. Perhaps it is the coffee shop where you used to go quite frequently for midnight snacks. Perhaps it is the area of town where he/she used to live. Perhaps it is the park where you had the picnic lunch one time. No matter the particular location, there are always places that remind you of the person you are trying to forget at the moment, and no matter how hard you try, the memories come back whenever you are in those locations.

Another example of the same kind of phenomenon is returning to a location where you used to live after a long period of time has elapsed. For most people, the town surrounding the university they attended provides an area that was very well known for a certain segment of their life, and then largely forgotten after they moved away. Suppose then that you return for a class reunion many years after your graduation. Driving down the old roads and seeing the old sights may bring back memories that you have not considered since you left the area. Thoughts of college friends and pranks pulled start to bubble up through your memory.

Both of these situations are examples of Environmental Context (EC) dependent memory. EC dependent memory is used to explain the experimental finding that recall of learned items is superior if recall takes place in the same environment in which learning took place. The traditional experimental paradigm for demonstrating these effects involves a list learning procedure followed by a recall test. The recall test takes place either in the same room that the learning procedure took place in (Same Context condition, SC) or a different room (Different Context condition, DC).

In the time since the first work was published in the area, the phenomenon has been demonstrated using a variety of to-be-learned material including CVC's (Rand & Wagner, 1967; Jensen, Harris, & Anderson, 1971), pertinent facts from a movie (Frerk, et al, 1985), words (Smith, 1979; Smith, et al, 1978) and an eight hour short course in statistics and statistical terminology (Smith & Rothkopf, 1984). The effect has also been found using a variety of mediums for the context manipulation including one study that used deep-sea divers to produce a context effect using an underwater vs. land manipulation (Godden & Baddeley, 1975).

However, despite the established nature of the phenomenon, experimental procedures designed to

demonstrate EC effects do not always succeed in replicating the effect. Even some attempts to replicate using the same learning materials and rooms used in earlier studies have failed to demonstrate the effect (Fernandez & Glenberg, 1985).

Recently, Eich (1985) has proposed an explanation of the EC effect that depends on subjects making use of a conscious memory strategy to encode the learning environment during the learning process. In his 2x2 experimental design, Eich varied the recall environment according to the traditional environmental context procedure. Subjects returned for their recall task either to the same room in which learning took place (SC) or to a different room (DC). Eich also varied the strategy used by subjects during the learning phase of the experiment.

In one condition, subjects were instructed to learn the words on a noun list by imaging them interacting with objects in the room using the method of loci. If subjects heard the word "dog", they would select a table or a bookcase or some other object in the room and visualize a dog with that object-- perhaps sitting in the bookcase and wagging its tail. After subjects formed the mental image, they rated it on its clarity and vividness. In the other experimental condition subjects also engaged in an imaging task, but were not instructed to combine the environment in any

way with their image. They might have imagined a dog wagging his tail, but their mental images were more free-floating and did not specifically take into account any of the context of the room environment.

Two days later in a free recall test, subjects who had used the method of loci to consciously encode the room context with the learning material suffered in recall when moved to a room different than the original learning room. Subjects who had imaged the free floating images performed equally well no matter if they returned to the same room or a different room.

Eich used these results to suggest that the EC phenomenon is the product of a conscious memory strategy. "..Automatic acquisition of contextual associations [is perhaps] a rarer phenomenon than previous research implies, and special methods... may be required in order for robust and reliable context dependent effects to emerge. (pg. 768)"

Several things argue against an interpretation that postulates the necessity of a conscious encoding process on the part of subjects. Ancedotal data of the kind mentioned in the introduction to this paper would lead us to believe that the EC effect may be found in the absence of a conscious memory strategy. In the case of a person trying to work through the breakup of a longstanding relationship, not only are people not consciously trying to use memory cues to facilitate

memory for that person, they are consciously trying to forget about the events they remember in the appropriate contexts. Popular psychology publications encourage people trying to recover from the breakup of a relationship to delete any references to the other person that exist in the environment. They are encouraged to take down pictures purchased by the other person, or even to move to a different location. Such things should not be necessary if people had access to conscious processes which served to explain the totality of the environmental context effect.

In addition, the whole environmental context phenomenon seems to be very non-intuitive. Subjects who have just finished participating in an experiment that replicated the phenomenon often exhibit blank stares when debriefed as to the purpose of the experiment. Until presented with real life examples such as those above, they tend to doubt the real life applicability of the effect. If in fact subjects do tend to use some sort of conscious strategy which is responsible for producing the EC effect, it seems that the majority of them would have a better grasp of the concept.

Perhaps there are conscious memory strategies invoked by a more traditional recall or recognition test which override the environmental context effect. In at least two different studies, Smith (1979; 1984) succeeded in wiping out the difference between same

context and different context subjects by having the different context subjects image the original learning environment while being physically in a different environment. In a recall or recognition test where you are requesting subjects to "think back" on a prior event, there is very little control over what tactics subjects will use to remember the required information. Even though subject reports (as mentioned above) would lead us to believe that few subjects use their environment as part of a conscious learning or retrieval strategy, the fact that they are successful in using that conscious strategy when requested to do so should make us sensitive to variability in our results that could occur because of within-subject differences in strategies used. Rather than being a necessary condition for EC effects to occur, in some cases perhaps conscious memory strategies prevent the effect from being found.

Recently, a variety of techniques for studying unconscious memory processes have been developed. In the research on unconscious memory, a distinction is made between explicit and implicit memory measures. In explicit memory measures such as recall and recognition tests, subjects are asked to consciously tap memory for earlier events. An implicit measure depends either on diverting subjects' attention from the purpose of the measure being taken or on tapping processes such as

reaction times that allow a somewhat cleaner view into the operation of priming processes in memory. Examples of unconscious memory measures that have been used recently in the literature are: homophone spelling (Eich, 1984; Jacoby & Witherspoon, 1982), recognition of degraded visual stimuli (Jacoby & Dallas, 1981), stem completion (Tulving, et al, 1982), and a wide variety of priming tasks (Moscovitch, 1982; Jacoby & Witherspoon, 1982; Schacter, et al, 1984).

In most cases, the implicit memory measures look for evidence of an effect of some earlier experimental event on the relevant measure (e.g. a high probablility of completing a given fragment of a word in a way which is congruent with an earlier experimental presentation) combined with a demonstration of independence between the implicit memory measure under study and a given explicit memory measure. Should subjects consistently respond in a way that would be expected given a bias induced earlier in the experimental procedure, and yet fail to remember relevant aspects of the event that induced the bias, the conclusion is made that the experimental procedure is tapping an unconscious memory process.

Much of the research using implicit memory measures has been performed using patients suffering from organic amnesia. The amnesiac syndrome occurs as a consequence of various types of neurological

dysfunction including Korsakoff's syndrome, closed head injuries and ruptured aneurysms (Cermak, 1982). The anterograde memory imparment of these patients, in opposition to the kind of amnesia usually portrayed in the media, leads to relatively intact memory for past events but severe impairment in the ability to encode new memories. The impairment in encoding new memories is such that these patients can learn new skills and yet have no memory for the learning episodes that led to the acquisition of the new skills. For example, amnesiacs can learn to solve the Tower of Hanoi problem and retain the solution over a long period of time while demonstrating little memory for external features of the learning episodes (Cohen, 1984).

With subjects demonstrating anterograde amnesia, dissociations between performance on explicit and implicit memory measures are relatively easy to demonstrate. Since these subjects have great difficulty remembering episodes, they typically do poorly on explicit recall or recognition type tasks. At the same time, they may show direct influences of a single learning episode on an implicit memory measure such as a homophone spelling task as demonstrated by Jacoby and Witherspoon (1982).

The purpose of the present experiment is to examine the Environmental Context effect using a homophone spelling task that has often been used as an

implicit memory measure (Eich, 1984; Jacoby and Witherspoon, 1982). Since explicit memory measures tap conscious memory processes which may override the effects of background context cues, a strategy free implicit memory measure may better reveal unintentionally encoded contextual associations. If retaining the environmental context present at the time of learning serves to enhance the performance of subjects on an implicit memory measure, Eich's (1985) explanation of the EC effect as the product of a conscious memory strategy would come under question.

A second purpose of the experiment is to examine Eich's proposition in the same article that perhaps the EC effect is mediated by mood change. Perhaps the environmental context effect occurs because subjects' moods are affected by their physical environment. A different, but related, body of research on state-dependent, and mood-dependent memory (Eich, 1980; Bower, 1981) suggests that internal physiological states can serve to cue memory for past events. Perhaps different environments serve to induce different mood states and the induced mood state and not a mental representation of the physical environment serves as a cueing mechanism.

We would also like to replicate using normal subjects the results of other experiments which have used implicit memory measures to measure the

unconscious processes of amnesiac subjects. Although not likely, the differential performance of amnesiac subjects on implicit and explicit measures of memory may be an artifact of the organic impairment they are experiencing. While the procedure for replicating the effect in normal subjects is necessarily more complex because of the greater event memory possessed by normals, the basic findings between the two populations should be equivalent if we are to assume that we are measuring different memory processes with explicit and implicit memory measures.

PROCEDURE

Subjects were 200 students in Introductory Psychology classes at Texas A&M University. Subjects participated in the experiment in groups of 6-12 people, and received course credit for participation.

At the beginning and end of the experiment, subjects filled out a "mood inventory"--a list of 50 adjectives and phrases describing mood states (e.g. "serious", "happy", "at rest"). Subjects rated each one of the 50 items on a four point scale (1- "does not apply", 4- "applies very much").

After completing the mood inventory, subjects listened to a recording of 64 word pairs. Instructions encouraged subjects to memorize the pairs in any way possible in preparation for a memory task that would be described after the recording was over.

Embedded in the list of word pairs were 16 homophones paired with a word which biased their less common spelling (e.g. "SAIL-boat", "eagle-PREY"). Also in the list were 16 homographs paired to bias their less common meaning (e.g. "cave-BAT", "factory-PLANT").

After the presentation of the word pairs was completed, subjects received a two-alternative forced-choice cued recognition test. One word out of each of the 64 word pairs served as a target, and subjects were asked to choose which of the two

alternative choices had been presented with the target word in the earlier audio presentation. In all cases the homophones and homographs served as the target word and both alternatives biased the same meaning of the target word as had been biased in the presentation list.

The experimental procedure was designed to encourate subjects to assume that the memory task involving the word pairs was over. The words "Final Memory Test" appeared prominently at the top of the recognition test. In addition, the environmental context manipulation was introduced at this point in the experiment, providing a further dissociation between the halves of the experiment.

Immediately after the "Final Memory Test" was completed, subjects were asked to leave the room while the experimenter prepared for the next half of the experiment. After 5 minutes, subjects returned either to the original presentation room (same context condition) or to a different room (different context condition).

Rooms were selected to be as different as possible. One room was a large, bright, 50 seat classroom on the third floor of the building. Subjects sat at individual desks spaced throughout the room. The other room was a small conference room on the second floor of the building, painted in an "academic green"

color that served to enhance the small size of the room. Subjects sat at tables with very little room between subjects.

When subjects returned from the break, they were given instructions to write the word "spell" on top of a sheet of paper. Instructions and task were again delivered by a tape recording. The recording contained a list of 32 words at 5 second intervals. In the list of words were 16 homophones; 8 old homophones which had appeared in their biased form earlier in the experimental procedure, and 8 new, unbiased homophones taken from the alternate presentation list used in the counterbalancing. Instructions directed to write down the words as quickly as possible, spelling the word in the first way that came to mind if they had any questions as to the proper spelling.

Subjects then heard a second list of 32 words presented at 5 second intervals. Instructions described this task as a "free association task" and were told to write down the first word that came to mind after hearing each list word. Embedded in this list were 8 biased/ unbiased homographs.

After the spelling and free association tasks, subjects received a 64 question two-alternative forced choice recognition test over the words on the original presentation list.

ANALYSIS OF RESULTS

In analyzing the results of the experiment, subjects were divided into two groups based on a mean split of the overall mood change measure. The average mood change experienced in the experiment was 27.61. Subjects experiencing overall mood differences of less than that value were designated the "Low Mood Change" group, and subjects experiencing mood differences greater than that value were designated the "High Mood Change" group.

A 2x2 ANOVA (Context vs Mood Change) calculation with number of biased spellings as the dependent measure demonstrated an overall context effect, $p<.05$. The effect of mood change approached significance, $p=.11$. The two effects did not appear to covary. Out of eight possible biased spellings, the SC/Low group had 3.39 biased spellings, the DC/Low group=2.64, SC/High=2.70, and DC/Low=2.39. Thus all effects were in the predicted direction with Same Context subjects biasing about 18% more words than Different Context subjects and Low Mood Change subjects biasing about 15% more words than High Mood Change subjects.

Recognition performance did not vary across the four cells with mean performance on the 64 item test at 85.32%.

There were no significant effects in the free association data even though all effects were in the predicted direction. Cell performances-- out of eight possible biased free associations-- are as follows: SC/Low=3.54, DC/Low=3.34, SC/High=3.48, and DC/High=3.32.

Independence can be assessed by comparing the two conditional probabilities: P(Recognition Hit | Biased Spelling) and P(Recognition Miss | Biased Spelling). The probability of recognizing a list homophone given that it had been spelled in a biased way, P(Hit|Biased Spelling)= .925. Probability of failing to recognize a homophone given a biased spelling, P(Miss|Biased Spelling)=.892. Traditionally, analysis of independence has been performed using Chi-square analysis, a non-parametric technique of low power (e.g. Eich, 1984). In order to increase the power of our test, the above mentioned probabilities were analyzed as two levels of the same within subject variable. Even with this much more powerful test, results still indicated independence (p=.09) even though there was a trend toward dependence.

In order to evaluate mood change as a possible mediator of the context effect, Mood Change was analyzed across the context manipulation. Total Mood Change for SC subjects was 27.71, total Mood Change for DC subjects was 27.51, a nonsignificant difference.

SUMMARY

The results of this experiment support the idea that in at least some cases the environmental context effect may operate in the absence of a conscious memory strategy. Results in both the free association and spelling tasks were in the directions predicted by the context effect, with fewer biasings present in the different context situation. The homophone spelling task, an established implicit measure, showed a significant effect of the context manipulation. The free association test, although promising, needs to be further defined before continued use in an experimental setting.

Also interesting was the behavior of the mood variable. Although mood dependent effects have been found by others (Bower, 1981), the typical finding of mood dependent memory has depended on the use of some type of mood induction technique (e.g. hypnosis). The use of hypnotic subjects has been criticized by some because the known tendency of good hypnotic subjects to cooperate with the experimenter could lead to a confounding effect should the subjects be able to deduce the experimenter's working hypothesis. In this situation, rather than specifically manipulating the

mood of subjects we simply took a measure of subjects own internal processes.

Failing to find any evidence that mood mediated the context effect does not of course invalidate a theory that the environmental context effect is mood based, however, it might lead us to doubt the theory a little. Since the measure we used has not been previously validated, the failure to find a mediating effect of mood on the context effect might be subject to the criticism that the measure is simply ineffective.

Two points would argue against this. In an analysis of the mood measure undertaken after the analysis of the results of the experiment, it was found to be very similar to the Profile of Mood States (POMS), a validated measure which has been used in other experimental settings. Many of the items on our mood measure duplicate items on the POMS exactly, and the overall areas tested by the two measures correspond a great deal.

The second thing that argues against the mood measure being simply ineffective is the nature of the biasing effects found in subjects with high and low mood change. Theoretical formulations of state dependent and mood dependent memory would predict that greater congruity between internal state at the time of encoding and time of retrieval should facilitate

retrieval. Subjects in our experiment who experienced low mood change as measured by our questionaire did indeed demonstrate biasing effects of a kind that would be expected according to the theoretical operation of mood dependent effects.

Even though the independence measure used in analysing our experiment was much more rigorous than those used previously in analyses of independence, the results indicated that the spelling homophone task was tapping some non-conscious process. The fact that a reliable environmental context effect was demonstrated using this type of task rules out the explanation of the EC effect proposed by Eich (1985) that presupposes the necessity of some conscious form of encoding strategy.

In fact, based on the results of this study, an opposite explanation of the failure to replicate the EC effect may well be postulated. Perhaps conscious processes in some cases interfere with the operation of the more subtle contextual encoding that the environmental effect seems to be dependent on. If further study shows that the EC effect occurs reliably using implicit memory measures, then we may start to deliniate the types of individual strategies which subjects may use to override the context effect, and develop ways to study the kind of individual

differences that provide much of the noise in studies of this kind.

A final comment on these results involves Tulving's (1983) proposal of separate episodic and semantic memory systems. A great number of other studies have demonstrated the existence of priming effects of one learning episode on "semantic" tasks: lexical decision (Moscovitch, 1982), and visual discrimination (Jacoby & Dallas, 1981). In Tulving's formulation, these results may be explained by postulating the existence of an episodic trace to account for performance on explicit memory measures and a separate priming effect in semantic memory that accounts for superior performance on a semantic task.

However, what we see in this experiment is a very subtle priming effect of one episode on a supposedly semantic task (according to Tulving's distinction). The semantic priming effect is so subtle that it differs in strength depending on the amount of reinstatement of the context of one particular learning episode. That sort of subtle interaction between supposedly separate "episodic" and "semantic" systems should well lead us to question the validity of such a distinction.

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