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The Effect of Caffeine on Relationship Memory

Elsa Carodenuto
Butler University

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Elsa Carodenuto

Abstract

Recollections of participants' last failed relationship (first meeting, first kiss, and break-up) were examined as a personal flashbulb memory (FBM). Although FBM is usually caused by arousal at encoding, the effects of arousal at retrieval was investigated by giving participants caffeine to determine its effect on elaboration at recall. 72 Butler students completed a protocol containing narrative and probe sections on each event of their last relationship. Results showed that caffeine enhanced memory of events at retrieval.

Background

Most memory research conducted on caffeine is at the time of encoding and not retriveal. The present study looked at arousal through a caffeine manipulation on relationship memories. Three elements of relationship memories (meetings, kisses and break-ups) were used because they differ in inherent arousal (meetings -- low, kisses and break-ups -- high) and valence (meetings and kisses are pleasant, break-ups aversive) (Hinton, 2006). Comparing the effects of caffeine across memories that are related but systematically differ in encoding emotions, any interactions of arousal at retrieval with encoding emotion can be determined. Therefore, the purpose of this study is to investigate the effects of arousal on autobiographical memories during recall.

Flashbulb Memories

"Flashbulb memories" (FBM), coined by Brown and Kulik (1977), described the surprisingly vivid and detailed accounts people gave for their discoveries of public disasters. Autobiographical memories, however, can be defined either as public (e.g., 9/11) or private (e.g., kisses) events. Early research looked mostly at public negative events (see Bohannon & Symons, 1991) and not until recently have more private forms of FBM been examined. Both public and private events elicit strong emotions with the same type of memory elaboration in individuals, showing that a car accident or a first kiss can be remembered in just as much detail as 9/11. In both events, minute details such as location of event, prior activity, time of day, and even the weather can be recalled months, even years after the event occurred (Christianson & Hubinette, 1993).

The primary determinants of these detailed memories appear to be a high level of

surprise, consequentiality, and emotional arousal. Although these memories are high in emotion, there is a forgetting curve corresponding to the amount of emotion at the time of encoding that influences the amount of detail remembered. Those events, such as being attacked or mugged, elicit so much emotion at the time of encoding, people tend to forget many details. On the other end of the spectrum, if one is highly unemotional at an event, few details of that specific memory will be remembered. Therefore, medium arousal is needed in forming flashbulb memories (Christianson, 1993).

In arousing events that form flashbulb memories, Robinson (1980) suggested that it is not the type of emotion but the intensity that is key. He exposed subjects to a series of cue words of common objects and actions and instructed them to recall the first personal incident that came to mind. Subjects rated the intensity of the emotion related to the recalled event, and he found that the intensity of the emotion was the only factor significantly related with the retrieval time. The stronger the emotion, the faster the memory came to mind. One explanation is that a heightened state of emotion may lead to a person paying more attention to the details of the incident and allowing more details to be encoded. Another explanation could be that higher levels of emotion trigger your brain to remember those incidents via an evolutionary mechanism designed to remember events that are more arousing.

Conflicting Views

The nature of flashbulb memories is underscored by two conflicting views. One view emphasizes the importance of emotion at memory encoding (Julian, Bohannon & Aue, 2008). The other view contends that memory is reconstructed at recall which can undermine accuracy (Neisser & Harsch, 1992; Talarico & Rubin, 2003). Thus, one mechanism focuses on initial encoding conditions as important and the other identifies recall as preeminent in determining the

extent and quality of memory. Carodenuto and Bohannon (2010, May) manipulated mood with different music to investigate the effect of matching valence at retrieval with that experienced at encoding. They concluded that the act of recalling the event changed the subject's mood and not vice versa. Thus, emotion at the point of encoding seems to have been preeminent in memory rather than emotion during recall. However, it is unknown whether this is the same for arousal and not just for emotional mood.

Recall of personal discovery details are enhanced as a result of hearing surprising news from an individual, but hearing the results from the media enhanced fact recall (Bohannon, Gratz & Symons, 2007). Therefore, the ability to recall depends on how one received the information.

The FBM arousal mechanism supposedly works to enhance memory for whatever one was processing at the time of being shocked. Those hearing factual information concerning the event through the media had more elaborate factual details. Those hearing the awful news from another person were more likely to process their discovery context, thus, enhancing recall of their personal details (Rice, 2010). Unfortunately, whatever people recall about their discoveries of shocking news tend to be idiosyncratic and not verifiable.

Recall and Consistency

The debate of FBM consistency and accuracy has gone back and forth. The debate is over the accuracy of these special memories and the veridicality of idiosyncratic recall (Rubin & Kozin, 1984; Neisser, 1982). One study going against the veridicality of FBM was done by McCloskey, Wible, & Cohen (1988). After the Challenger explosion, they tested subjects regarding their memory of this public tragedy. Nine months later, they tested the same subjects again (N=27) and found inaccuracies and substantial forgetting. Because of the inconsistent recalling 9 months later and subjects' high confidence, they concluded that FBM were no better

than ordinary memories.

However, a study by Bohannon and Symons (1992) tested 116 subjects two weeks after the Challenger explosion and then 3 years after the event. Although they found inconsistencies in many of the participants recalling of the Challenger explosion, these participants showed low levels of arousal at the discovery of the event. Christianson (1989) also found similar results in his study on the assassination of the Swedish prime minister, testing the participants (N=139) after the assassination and then one year later. He found results indicating that flashbulb events are accurately recalled in terms of a narrative conception of the concomitant circumstances of the event but that the event descriptions are not consistent with respect to the specific details of these circumstances. These memories appear to be reconstructions based on residuals of the circumstances concomitant with the specific event (i.e., that of first hearing of the shocking news), and these memories follow the same pattern of recollection, as does recollection of other autobiographical and laboratory-induced emotional events.

This shows flashbulb memories must have high levels of arousal to result in more extensive, vivid, and consistent memories. One cannot conclude that it is not up to the experimenter whether an event is high in arousal, since one person might be affected by a tragic public event significantly more than another person. If the participant has a high level of arousal at the time of encoding the memory will be longer lasting and less apt to corruption and loss over time (Christianson, 1989; Conway, 1994; Bradley, Bohannon & Symons, 1992).

Furthermore, looking at the different studies, those with a higher number of participants saw more consistency and accuracy. Studies on flashbulb-like memories need power, the more participants the more power, to be able to be confident in their results. Some of the studies concluding flashbulb memories are inaccurate and see loss over time do not have the amount of

participants needed, and there could be noise in the data to skew their results (e.g., Talarico & Rubin, 2003; Weaver, 1993). Studies with high participant numbers (Christianson, 1989, Bohannon & Symons, 1992) were more apt to be able to see wider range of arousal of the flashbulb memories with little effect from outliers.

Arousal and Valence

Autobiographic memories are influenced by emotions. Conway (1995) noted, when a life event causes a major change in personal plans or views, it results in a high level of emotion. Personal impact of an event causes an increase in emotion causing more attention and deeper encoding of the specific event. Some of these events, with such high emotions, can be defined as flashbulb memories.

As stated earlier, Brown and Kulik (1977) first used the term flashbulb memory to describe the surprisingly vivid and detailed accounts people gave for their discoveries of public disasters. Brown and Kulik (1977) looked specifically at the tragic event of John F. Kennedy's assassination and people's memory of this event. The news of John F. Kennedys's death was rated by participants as having high levels of surprise. These high levels of surprise were one of the determinants they believed correlated with the highly detailed and vivid account described for their discovery of JFK.

Robinson (1980) suggests that the intensity, and not the type, of the emotion is key. He exposed randomly assigned subjects to a series of cue words of common objects and actions. He instructed participants to recall the first personal incident that came to mind. Subjects then rated the intensity of the emotion of the recalled event. Robinson (1980) found that the intensity of the emotion was the only factor significantly related with the retrieval time. The stronger the intensity of the emotion, the less time it took to retrieve a memory. Furthermore, in a study done

by Tekcan (2001), college students' memories of different valences were compared to determine if negative or positive valence has an effect on memory. The events used were the beginning of Operation Desert Storm, a negative event, and acceptance to college, a positive event. Students showed no significant differences between the two events in the amount of detail remembered. This suggests the type of affect is not what determines the qualities for flashbulb memories, but the amount of arousal.

This was also found by Hinton and Bohannon (2006) where arousal and rehearsal across and within events (first meeting, first kiss, break-ups) was a significant predictor of the extent of one's autobiographical recall, even though break-ups and first kisses differ in valance. The amount of arousal determined how much was recalled. The high arousing events (first kiss and break-ups) were vividly recalled compared to low arousing events (first meetings). Low arousing events were significantly different from arousing events in vividness and elaboration. This was also found in Reed and Bohannon's (2000) study of first meetings and first kisses. The accounts of first kisses were more consistent between partners regardless of delay between the events. Therefore, the higher intensity in arousal and surprise a memory has, the more vivid the memory will be recalled later. Thus, recall will be more accurate and in greater detail in highly arousing events.

Prior research focused primarily on aversive emotional events, including assassinations (Colgrove, 1899; Pillemer, 1989; Yarmey & Bull, 1978), shuttle explosions (McCloskey, Wible, & Cohen, 1988; Bohannon, 1988; Neisser & Harsch, 1992), and terrorist attacks (Schmidt, 2004; Pezdek, 2002; Talarico & Rubin, 2002) to show enhanced memory for the emotional autobiographical event. If these memory mechanisms hold true for flashbulb memories of aversive events, similar mechanisms also must be present for events that are pleasant in valence.

Recent findings have shown pleasant emotional events, such as a first kiss, to evoke these long lasting and vivid memories containing flashbulb-like mechanisms as well (Reed & Bohannon, 2000; Gillott & Bohannon, 2009).

Bradley et al. (1992) examined the interaction of varying dimensions of valence and arousal on memory performance. She made slides ranging from high to low valence and arousal. Consistent with previous research, memory for the high arousing slides were better in elaboration than the low arousal slides. This is also seen in Hinton and Bohannon (2000) where events higher in arousal (first kisses and break-ups) were more vividly recalled than low arousal events (first meeting).

Mood

Eich (1995) looked at Mood-Congruency (MC), which is seen when the current/given mood enhances recall of mood-congruent material. Being happy at retrieval enhances recall of happy TBR (to be remembered) material, independent of the conditions of encoding. Mood-Dependency is when the current mood at retrieval is the same as the mood at the time of encoding, which helps recall, independent of the valence of the TBR material. Eich (1995) looked at the effect of combining music with thought to change mood. Mood manipulation has been done in previous work (done by Camp, Pignatiello, Rasar, 1986) with read self-referential statements. Bower (1981) found the recollection of sad versus happy stories in incongruent and congruent memories to be mood-dependent. Therefore, recalling facts of the stories were significantly more elaborate for congruent mood manipulation at recall.

However, in a recent study by Carodenuto and Bohannon (2009) found that participants in a sad music mood-induction remembered more of a congruent memory (worst kiss) than participants induced in a happy mood (remembering best kiss). This is one of the first

autobiographical memory experiments with mood, since most prior work looks at semantic memory. They found that when moods were induced, the act of recalling an event of a differing valence significantly changed the perceived mood state to one more congruent with the valence of the memory. This may be since best kisses are not always happy after the event occurred. Some participants may think of their best kiss as happy, but it may also evoke sad thoughts since they may no longer be with their best kiss partner currently. However, interestingly the act of recalling the event rapidly changed the subject's mood. Meaning that the mood induction had an effect, but participant elaborated on certain memories more to assist in changing the mood to a more substantial and stable. For example, subjects manipulated into a sad mood quickly became happy when required to recall their best kiss.

They found these affects of mood by using the Valance and Arousal Survey, first designed by Russell, Weiss, and Mendelson in 1989 and then adapted by Eich in 1995. If no effects of mood-congruency were seen in best and worst kisses, would the same effects be seen in arousal? Arousal has been known to have an effect on memory at encoding (Brown & Kulik, 1997; Julian, Bohannon & Aue, 2009). Knowing that arousal has an effect at encoding, will enhancement also be found at retrieval?

Caffeine

Caffeine is a stimulant known to allay drowsiness and fatigue, to sustain intellectual effort and a more perfect association of ideas, and to enhance a keener appreciation of sensory stimuli (James, 1991). Few well-controlled studies of caffeine's effects on performance are available with the different levels of caffeine doses (Loke, 1988). By looking at the different effects of caffeine on memory, a medium-low dose of caffeine (200 mg) has been seen to be the best dosage to be used for memory experiments. A medium dose has shown to increase memory

span, allay drowsiness and fatigue, enhance a keener appreciation of sensory stimuli, unlike a high does (400 mg) which decreases recall (Loke, 1988). Low doses (5mg) produce no effect or influence arousal (Herz, 1999).

Also, the effects of caffeine are similar and not modified by the nature of the caffeine drink but only by the amount of caffeine in the drink (Smith, 1999), showing no difference in the type of caffeinated drink being used. Caffeine in medium doses (200 mg) enhances performance effects in low memory load tasks but decreases performance in high memory load tasks (Durlach, 1998; Lieberman, 1992; Loke, 1988). Thus, a difference in memory should be seen when comparing the low-load probed response versus the high-load narrative.

Gillott, Leider and Bohannon (2009) recently found that glucose specifically inhibits narrative recall of autobiographical memories of kisses but not for probed recall. It is unknown if this would be the same for caffeine. It is also unknown whether the valence of an event, pleasant or aversive, interacts with the arousal of an event to determine recall when the elements of the encoding affect state are matched. Matching valences of mood without matching arousal failed to show memory differences (Carodenuto & Bohannon, 2010).

Relationships

College relationships are especially memorable due to their novelty and a marked sense of adulthood during this transitional period. The "reminiscence bump" (Conway & Pleydell-Pearce, 2000) describes the overrepresentation of recollected memories occurring during early adulthood reported by mature adults. Conway and Pleydell-Pearce defined the reminiscence bump as the period between 10 to 30 years, because of all the life-changing experiences during this time. Converging evidence indicates that the knowledge acquired during the reminiscence period is highly accessible, more accessible than knowledge outside this period. One reason is

the novelty of the experiences; someone's first kiss, first sexual experience, graduation and buying their first house. These first experiences are more exciting and arousing, which concludes a deeper level of processing the memory and it becomes integrated and recalled with later knowledge in distinctive and accessible ways. In support of this phenomenon, Pillemer (2001), examined the first memories of current college students and a sample of alumni who had graduated approximately 22 years ago. Pillemer found memory peaks at the beginning and ending of school years, where their experiences were the most novel (first semester) and/or arousing (graduation). One event that typically occurred during his experiment for these college students is their recall of their first serious relationship.

Memories during relationships can be flashbulb memories because of their accuracy and arousing components. The amygdaloid response during sexual situations (first kiss) (Ashby, Isen & Turken, 1999; Cahill & McGaugh, 1996) is the same mechanism used with aversive and defensive arousal (i.e., flashbulb memories). The amygdala's primary role is processing memories of emotional reactions. Therefore, the amygdala could be responding not only in what some believe to be the typical flashbulb memory, but also in memories of first kisses, first sexual experiences, and in break-ups.

Alter (1998) tested people's memories for their first kiss with their current partner in a fashion similar to the techniques used for flashbulb memory. Also since kisses are shared events, she examined the accuracy of the memory by comparing individuals' memories for their first kiss within couples. She found that couples with high levels of initial arousal and many retellings of the kiss story had more extensive and more consistent kiss memories, identical to what is found in forming accurate flashbulb memories.

However, Bohannon & Reed (2002) showed that individuals who witness or experience

the same romantic event together may recall the event in a different manner. Couples actively dating individually reported their first meeting and first kiss; couples' consistency was only 26% for their memory of first meetings and 40% for their memory of kisses. This shows that events with higher arousal (kisses) are remembered more consistently than lower arousing events (first meetings). Further research by Hinton and Bohannon (2006) confirmed first kisses were not only higher in arousal but were more elaborate than first meetings.

The present study looked at arousal through a caffeine manipulation on relationships. Three elements of relationship memories were examined (meetings, kisses and break-ups), these memories differ in their inherent arousal (meetings -- low, kisses and break-ups -- high) and valence (meetings and kisses are pleasant, break-ups aversive) (Hinton, 2006). Comparing the effects of caffeine across memories that are related but systematically differ in encoding emotions, any interactions of arousal at retrieval with encoding emotion can be determined. Therefore, the purpose of this study is to investigate the effects of arousal on autobiographical memories during recall.

Hypothesis

1. Comparing the effects of caffeine across memories that are related but systematically differ in encoding arousal, an interaction of arousal will be seen at recall.
2. A. Higher levels of arousal (i.e., first kiss and break-ups) would elicit greater elaboration during recall.

   B. Higher levels of arousal would elicit greater vividness during recall.
3. Participants that are more aroused at the time of retrieval (i.e., caffeine manipulation), will elicit a great memory.

Methods

Participants

72 undergraduate students who had been in a romantic relationship lasting at least six months that had since terminated one month prior to recruitment participated in this study. The majority of students were recruited from psychology classes and given extra credit from the professor. A small sample was recruited from Greek houses.

Procedure

All participants were informed of the general nature of the study and then signed consent forms. Participants were then given a cup of coffee; where half were given caffeinated coffee (200 mg/ experimental group) and half were given a placebo of decaffeinated coffee (5 mg/control group). In both cases, a sugar substitute was used for those participates who wanted to sweeten their coffee. Since it takes 15 minutes for the caffeine to take effect, participants were asked to fill out a word search for 15 minutes after the intake of coffee and before starting the protocol. After fifteen minutes of the distractor task, the participants were instructed to recall elements of a failed relationship: meeting, first kiss and breakup. Subjects were told to complete the questionnaire at their own pace.

Measure

The participants' mood was assessed during the protocol using the Eich (1995) mood-measurement method (see Figure 2). Their mood was assessed before consuming the caffeine, after finishing the distractor task, and after recalling each event: meeting, first kiss, and breakup. This determined the effect caffeine had on the participants throughout the experiment and also the effect their memory had on their physical and emotional arousal for each event.

Questionnaire

All participants completed a questionnaire, which examined three elements of a romantic relationship: the first meeting, the first kiss, and the breakup. Each event had a probe and narrative section. In the narrative section, subjects were asked to recall the event with as much detail as possible, including internal feelings as well as any external events occurring during the given romantic event.

In the probe section, participants were asked to answer specific questions such as the location where the event took place and the clothes the former partner was wearing. Participants rated how confident they were in their answer after each probed question on a scale of 1 (not sure at all) to 5 (extremely confident). After each probe section, arousal and vividness were also measured for each romantic event using a five-point rating scale. The arousal and vividness were measured on a 5-point scale, which ranged from 1 (couldn't have cared less) to 5 (absolutely ecstatic/extremely agitated).

In the last section, questions concerning the relationship were asked. For example, how long did this relationship last, how many relationships have you had, and who broke up with whom.

On the last page, there was a short questionnaire for participants to fill out concerning their caffeine intake and caffeine effects. For example, the questionnaire consisted of questions like, how much caffeine do you intake per day in mgs (examples of caffeine amounts were given) and how anxious do you feel after having a cup of coffee.

Scoring

Free recall narratives for each event were scored for the seven canonical features, coined by Neisser & Harsch (1992). The canonical features included: activity, location, time, subject's affect, others' affect, others present, and aftermath. Each feature was scored a 0, 1, 2, or 3

depending upon the elaboration of the memory. A score of 0 was given if the canonical feature was not mentioned, 1 if there was a vague or implicit mention of the feature, 2 if there was one explicit mention of a given feature, and a 3 if more than one explicit feature was mentioned or one explicit feature was stated more than once. The free recall estimate reflected the extent of memory and was derived by calculating the average elaboration score (0-3) across all seven canonical features for each event. The probed sections were scored similarly, but only ranged from 0 to 2. A score of 0 was given if nothing was stated, 1 was given for a vague answer, and 2 was given for an elaborate answer. The probe sections were also calculated by adding the total points and then dividing it by 2 to compare to the other events.

For inter-rater reliability, 15 lab members scored three narratives and probes. Results were written across a score sheet and when there was 90 percent or higher accuracy within scoring for all individuals, that scoring sheet was used. There was a 92 percent inter-rater reliability found and the remaining protocols using the same scoring rules that had the 92 percent inter-rate reliability.

Results

Hypothesis 1: Effects of caffeine across memories

Arousal

Using ANOVA, we found that participant's arousal ratings did not differ across caffeine group, $F(1,45) = .23$, $p <$ NS, meaning that those with caffeine did not change participant's estimates of their arousal at encoding of the events. This might effect our hypothesis, since participants in the high aroused group did not feel more aroused and the caffeine might not have been effective for participants.

Memory

By comparing the effects of caffeine across memories that are related but systematically differ in encoding emotions, we found that there was an overall memory effect, $F(2,120) = 15.4$, $p < .0001$. Caffeine aroused subjects remembered more. This confirms hypothesis one, indicating that those participants more aroused at retrieval remember more overall.

Probe and Narratives

The probe section confirmed hypothesis one, seeing as participants in the caffeine group remembered more than those in the decaffeinated group, $F(1,44) = 8.24$, $p < .006$. Interestingly only probes but not narratives had a memory effect with the caffeine manipulation, $F(1,44) = .64$, $p <$ NS and $F(1,44) = 10.38$, $p < .003$. This brings controversy to hypothesis one, since arousal and retrieval had an overall memory effect but when looking at the two forms of memory recall, only probes aligned with our hypothesis.

Vividness

There was a caffeine effect for vividness, $F(1,44) = 7.25$, $p < .01$, meaning that those in the caffeine group had a more vivid memory compared to those in the decaffeinated group. This shows that not only does higher arousal at retrieval alludes to a more extensive memory, but also having higher arousal at the time of retrieval alludes to a more vivid memory.

Hypothesis 2A: Higher levels of arousal would elicit greater elaboration during recall

Arousal

The adapted mood graph by Eich (1995) was used to assess pleasance and arousal (see Figure 2). Participants' arousal was significantly different across events, $F(2,90) = 12.54$, $p < .0001$. Meetings ($M=3.26$) were significantly different from kisses ($M=4.3$) and break-ups ($M=3.87$), but there was no significant difference found for kisses and break-ups. This shows

that we can compare these events to see if an effect on arousal during encoding had an effect on recall (i.e., hypothesis 2A).

Probe and Narratives

The type of memory recall across events was measured using a series of one-way ANOVAs. Results showed that across events, there was a significant difference in recall for probes, $F(2,90) = 20.85$, $P < .0001$. Meetings (M=. 787) and kisses (M=. 77) were more elaborate then break-ups (M= .67) for the probe section (see Table 1).

Not only was there a significant difference across probes, but across narratives for each event, $F(2,90) = 5.75$, $p < .005$. Narratives however, were not as elaborate as probes, $F(1,60) = 246.8$, $p < .0001$, (see Figure 1).

These findings show that hypothesis 2A was supported since the higher aroused the participant was at the time of the event, the greater the elaboration was during recall.

Hypothesis 2B: Higher levels of arousal would elicit greater vividness during recall

Vividness is a qualitative, self-perceptive measure of memory, but can be quantified and scored on a 5-point scale (Bohannon & Symons, 1992). In this study, vividness also mirrored arousal and narratives, where meetings (M= 2.98) were less vivid than kisses (3.74) and break-ups (M= 4.72), (see Table 1), confirming hypothesis 2B by showing the relation of arousal at encoding and its effect on the elaboration and vividness of the memory. Furthermore, vividness was significantly different across events, $F(2,90) = 9.29$, $p < .0002$.

An exploratory analysis was conducted for recounts

Recounts were not significant $F(2,90) = .49$, $p <$ NS. Mirroring of events was not seen with recounts. This shows that arousal at the time of retrieval has a greater impact on the extent to which the event will be remembered than how many time one recalls the memory

subsequently. This was also found by Hinton (2006) where effects of rehearsal and affect on all the memory variables were measured to see which would lead to more extensive and vivid memories. In her study, she found that affect played the largest role and vividness was a significant predictor of how much participants would remember, whereas rehearsal played a more marginal role and was not significant.

These results support the efficacy of affect on autobiographical flashbulb memories in both public (e.g., Bohannon & Symons, 1992; Christianson, 1992) and private emotional events like romantic rejections (Beer & Bohannon, 2001). Arousal across and within events was a significant predictor of the extent of one's autobiographical recall.

In some studies however, arousal has not been seen as a significant predictor of memory elaboration. Conversely, these studies can not be seen as reliable, since they either have so few subjects that their analyses lacked power to resolve noisy memory differences (e.g., Talarico & Rubin, 2003; Weaver, 1993) or have little variance in arousal (Schmidt, 2004).

Conclusion

The major goal of this study was to examine the role arousal at encoding and retrieval had on memory. Most studies look at only the effects of caffeine at the time of encoding but not retrieval. In the present study, we looked at arousal through a caffeine manipulation on different relationship memories, to see the effects of arousal at both encoding and retrieval. Three relationship memories (meetings, kisses and break-ups) were used because of they differ in inherent arousal (meetings -- low, kisses and break-ups -- high) (Hinton, 2006). Comparing the effects of caffeine across memories that are related but systematically differ in encoding emotions, any interactions of arousal at retrieval with encoding emotion can be determined.

By comparing the effects of caffeine across memories that differed in encoding emotions, we found that there was a memory effect. That the more arousing the event is, the more one will remember at recall. Therefore, kisses and break-ups were remembered significantly more than first meetings. Furthermore, using caffeine at retrieval, those in the caffeine group remembered more overall then those in the decaffeinated group. This means that it is not only arousal at encoding that enhances one's memory of an autobiographical event, but also how aroused one is at retrieval.

Although overall memory was enhanced in the caffeine section, probes but not narratives had a memory effect with the caffeine manipulation. This result confirms Loke (1988) research using medium doses of caffeine. He found that low memory loads (i.e., probe section) are enhanced with medium doses of caffeine. However, one major difference between this study and past research, such as Loke, they do not look at arousal during both encoding and retrieval. Loke study only examined arousal effects administered during encoding.

In this study, those in the caffeine group were able to remember significantly more than those in the decaffeinated group. Also, those events at the time of encoding that had higher arousal were more elaborate and vivid. Furthermore, easier memory tasks are found to have an enhancing effect with caffeine. Therefore, one will be able to recall more of a highly rousing episodic memory while having consumed caffeine when the memory is cued.

Participants' arousal rating times were significantly different across memory of events. Probed memory across events mirrors vividness and narratives arousal. This mirroring, however, was not seen with recounts. This shows that arousal and vividness at the time of retrieval has a greater impact on the extent to which an autobiographical event will be remembered later, than recounts do. This effect is not surprising since it has been seen is prior

research (Hinton 2006 and Reed 2000), where arousal have a significantly greater impact on memory compared to rehearsal.

While this study attempted to explore the idea of arousal that has been relatively untouched, it was not without flaw. This study was completed in sequential order, meaning that all participants recalled their relationship memories in the same order (first meeting, first kiss, and then break-up). This may have had an effect especially with fatigue since it took approximately 30 minutes for the participants to complete. Furthermore, mood could have also played a role, since recalling a sad memory after a happy memory (first kisses followed by break-ups) may lead to a difference in elaboration to amend their mood (Carodenuto, 2010). Therefore, to further this study, the order of event memories recalled should be changed in the protocol to further confirm these results. Although test effects, such as fatigue could have played a role; environmental and time conditions as well as procedure were all controlled to the best of the researchers' abilities to keep these effects at a minimum. Therefore, in the future this study should be administered to a larger number of participants, to be able to change the order of the protocol, to eliminate effects of fatigue and mood.

In summary, this study supports the notion that high levels of arousal can lead to greater and more substantial memory. That arousal not only at encoding, but also at retrieval is shown to have enhancing effects. This can also be seen in non-laboratory settings, where students taking an exam for class tend to do better in a medium aroused state and those who are very nervous or not aroused at all tend to do worse. Furthermore, at the time of studying, those that are at medium aroused levels tend to remember more information and detail than those who are tired or not aroused. Therefore, the next time you study for a test, make sure you are awake and aroused during studying and testing, especially during easier memory load types of tests (multiple choice,

fill-in-the-blank).

Although this study looked at memory elaboration and vividness on arousal, further research should look at participant's confidence in their responses. That although we found caffeine to enhance memory, does caffeine also elicit higher confidence in their memory? This may help to determine if participant's are more alert, making them elaborate more, but also confirming that they are truly confident that their answered are valid, meaning their memory is more vivid.

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Figures

Figure 1: Recall of Probed and Free

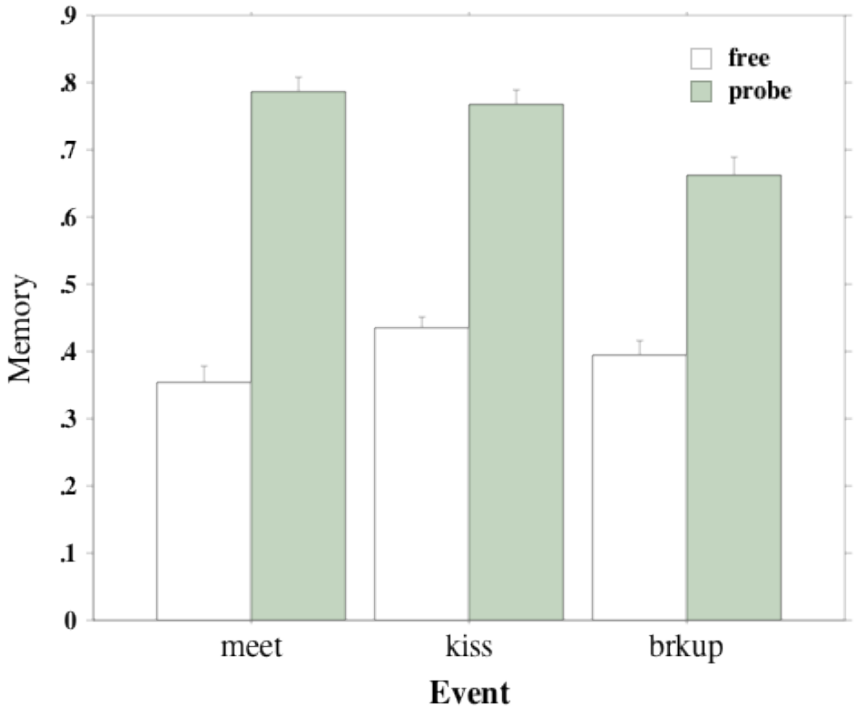
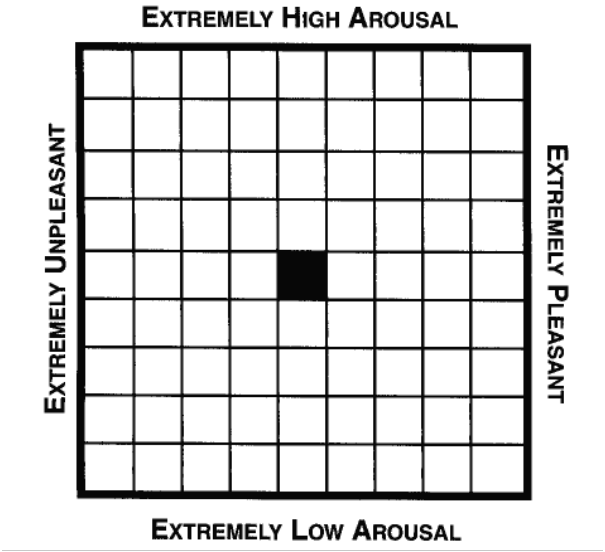


Figure 2: (Valance and Arousal Survey) First design by Russell, Weiss, and Mendelson in 1989 and then adapted by Eich in 1995.



Tables

Table 1: Differences between events

	Meeting	**Kiss**	**Break-ups**	**F (2,90)**	**p <**
Arousal	3.26	4.3	3.87	12.54	.0001
Valence	1.17	1.37	-.35	26.52	.0001
Recounts	3.87	4.08	4.72	.49	NS
Vividness	2.98	3.74	3.72	9.29	.0002
Narrative	.346	.436	.39	5.75	.005
Probe	.79	.77	.67	20.85	.0001

Tables 2: Caffeine effects on memory

	Caffeine	**Decaffeinated**	**F (1,44)**	**p <**
Vividness	3.69	3.12	7.25	.01
Memory	.594	.519	8.43	.006
Free	.401	.376	.64	NS
Probe	.787	.661	10.38	.003

Appendices

Appendix 1: The Protocol
Part 1

First Meeting

Please write a detailed account of your first meeting with your former partner. Be as inclusive and accurate as possible. Please detail both **internal** thoughts and feelings as well as **external** events (ie things you saw and heard at the time)

First Kiss

Please write a detailed account of your first kiss with your former partner. Be as inclusive and as accurate as possible. Please detail both **internal** thoughts and feelings as well as **external** events (ie things you saw and heard at the time).

The Breakup

Please write a detailed account of the breakup with your former partner. Be as inclusive and accurate as possible. Please detail both **internal** thoughts and feelings as well as **external** events (ie things you saw and heard at the time).

Part 2 First Meeting

Please answer the following questions as specifically as possible to the best of your recollection. Also, please rate your confidence in each answer according to the below scale:

1	2	3	4	5
Not sure at all	Somewhat confident	Moderately confident	Very confident	Extremely confident

1. What were you wearing when you met your former partner for the first time?_____
_____Confidence Rating:_____

2. What was your former partner wearing when you met for the first time? _____
_____Confidence Rating:_____

3. What were the first words spoken and who said them?_____
_____Confidence Rating:_____

4. What was the exact date of the first meeting? (Month/day/year)_____Confidence Rating:_____

5. What day of the week did you and your former partner meet?_____Confidence Rating:_____

6. What time did you meet? (to the nearest hour, AM or PM)_____Confidence Rating:_____

7. Where did you meet?_____
_____Confidence Rating:_____

8. What were you doing before meeting your former partner for the first time?_____
_____
_____Confidence Rating:_____

9. What was the weather like when you and your former partner met?_____
_____Confidence Rating:_____

10. Approximately how many times have you related this story of your meeting to another person?_____

Please circle your **arousal level** when you first met your former partner on the scale provided below.

1	2	3	4	5
Couldn't have cared less	Somewhat aroused /agitated	Moderately aroused/agitated	Very aroused/agitated	Absolutely ecstatic/ extremely agitated

Please circle the **vividness** of your memory regarding the first meeting on the scale provided below.

1	2	3	4	5
Extremely Vague/hazy	Somewhat vague	Moderately vivid	Very vivid	Extremely vivid/ like it happened yesterday

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Approximately how many relationships in total have you been in?_____

Please rank the seriousness of this relationship in the scale provided below.

1	2	3	4	5
Casual		Pretty serious		Engaged

First Kiss

Please answer the following questions as specifically as possible to the best of your recollection. Furthermore, please rate your confidence in each answer according to the below scale:

1	2	3	4	5
Not sure at all	Somewhat confident	Moderately confident	Very confident	Extremely confident

11. What were you wearing at the time that your first kiss occurred?_____
_____Confidence Rating: __

12. What was your former partner wearing at the time that your first kiss occurred?_____
_____Confidence Rating:_____

13. What were the last words spoken <u>before</u> the kiss occurred and who said them? _____
_____Confidence Rating:_____

14. What were the first words spoken <u>after</u> the kiss occurred and who said them?_____
_____Confidence Rating:_____

15. In what location did the kiss occur? (living room, movies, car)_____
_____Confidence Rating:_____

16. What was the exact date of the first kiss? (Month/day/year)_____Confidence Rating:_____

17. What day of the week did the kiss occur?_____Confidence Rating:_____

18. What time did the kiss occur? (to the nearest hour, AM or PM)_____Confidence Rating:_____

19. What were you and your former partner doing prior to the kiss?_____
_____
_____Confidence Rating:_____

20. Approximately how many times have you related this story of your first kiss with your former partner to another person?_____

Please circle your **arousal level** at the time of the first kiss with your former partner on the scale provided below.

1	2	3	4	5
Couldn't have cared less	Somewhat aroused /agitated	Moderately aroused/agitated	Very aroused/agitated	Absolutely ecstatic/ extremely agitated

Please circle the **vividness** of your memory regarding the first kiss on the scale provided below.

1	2	3	4	5
Extremely Vague/hazy	Somewhat vague	Moderately vivid	Very vivid	Extremely vivid/ like it happened yesterday

Please circle the level of **surprise** you experienced during the first kiss on the scale provided below.

1	2	3	4	5
Couldn't have cared less	Somewhat surprised	Moderately surprised	Very shocked	Absolutely shocked and amazed

The Breakup

Please answer the following questions as specifically as possible to the best of your recollection. Further, please rate your confidence in each answer according to the below scale:

1	2	3	4	5
Not sure at all	Somewhat confident	Moderately confident	Very confident	Extremely confident

21. Who initiated the breakup?_____ Confidence Rating:_____

22. What were you wearing at the time that you and your former partner broke up?_____
_____ Confidence Rating:_____

23. What was your former partner wearing at the time that you and your former partner broke up?_____
_____ Confidence Rating:_____

24. What were the last words spoken <u>before</u> the breakup occurred and who said them?_____
_____ Confidence Rating:_____

25. What were the first words spoken <u>after</u> the breakup occurred and who said them?_____
_____ Confidence Rating:_____

26. Where were you at the time of the breakup? _____
_____ Confidence Rating:_____

27. What was the exact date of the breakup? (Month/day/year)_____ Confidence Rating:_____

28. What day of the week did the breakup occur? _____ Confidence Rating:_____

29. What time did the breakup occur? (to the nearest hour, AM or PM)_____ Confidence Rating:_____

30. What were you doing before the breakup? _____
_____ Confidence Rating:_____

31. Approximately how many times have you related this story of your breakup to another person?_____

32. Approximately how long did the relationship last?_____

Please circle your **arousal level** while breaking up with your former partner on the scale provided below.

1	2	3	4	5
Couldn't have cared less	Somewhat aroused /agitated	Moderately aroused/agitated	Very aroused/agitated	Absolutely ecstatic/ extremely agitated

Please circle the **vividness** of your memory regarding the breakup on the scale provided below.

1	2	3	4	5
Extremely Vague/hazy	Somewhat vague	Moderately vivid	Very vivid	Extremely vivid/ like it happened yesterday

Please circle the level of **surprise** you experienced after the breakup on the scale provided below.

1	2	3	4	5
Couldn't have cared	Somewhat surprised	Moderately surprised	Very shocked	Absolutely shocked and amaze

Appendix 2: Narrative scoring rubric for seven canonical features.

Canonical Features	**Definition**
Activity	Actions of the person leading up to the event
Location	Where the person is at during the event
Time	The time when the event occurred
Aftermath	Any actions occurring after the event
Author's Affect	The emotional state of the writer leading into, during, and immediately after the event
Others Affect	The emotional state of the former partner leading into, during, and immediately after the event
Others Present	Others implicitly or explicitly stated (not including their romantic partner)

Appendix 2a: Example of scoring for a canonical feature
Activity (The activity - of any character - must be from that day of the meeting…)

0	There is no activity mentioned/implied
1	The activity is implied. There is no concrete way to tell one specific activity. *("I was on my way to class…"* implies walking or running, *"After a movie"* implies watching, *"Came for dinner"* implies eating, "waiting for opportunity") Vague activities *("Went…" "Took her to…" "Made a stop at her house" "Pulled up to my driveway" "Dropping me off" "Arrived" "Hanging out"*)
2	Anything the scorer can physically imitate what the person was doing, without any doubt – a specific act. *("Walking" "Eating" "Standing" "Laying" "Got in car" "Asked" "First time I had sex" "Waiting for bus"*) Nothing implying affect. (NOT *"Smiled")*
3	The activity is mentioned more than once, but separately (*"We walked to study hall… I turned to walk away")* or more than one activity is mentioned. *("I packed my books and walked to the door when…"*)