



5-12-2012

# The Effect of Affect on Group Memory

Dominick Joseph Atkinson  
*Butler University*

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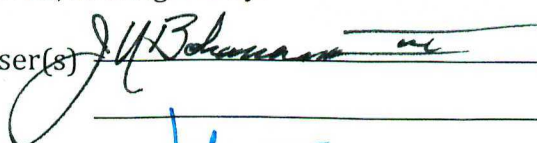
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Thesis title The Effect of Affect on Group Memory

Intended date of commencement May 12<sup>th</sup> 2012

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Date

Reader(s)  5/3/12  
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Director, Honors Program Date

For Honors Program use:

Level of Honors conferred: University \_\_\_\_\_  
Departmental Psychology with Honors  
\_\_\_\_\_  
\_\_\_\_\_

**The Effect of Affect on Group Memory**

A Thesis

Presented to the Department of Psychology

College of Liberal Arts and Sciences

Of

Butler University

In Fulfillment

Of the Requirements for Departmental Honors

Dominick Joseph Atkinson

May 3<sup>rd</sup> 2012

## ABSTRACT

Memory typically improves when recollecting in a group – the larger the group, the better the memory (McClure 2010; Atkinson 2011). High arousal at the time of encoding also improves memory (Bohannon, Gratz, & Cross 2007; Libkumen, et al., 1999). In this study 342 participants viewed either an emotional or neutral slideshow and then recalled either alone or with a group of three (triad). The participants were tested using both probed and free recall questionnaires. We found that for perceptually central items, the emotional material only helped the individuals, and not the collaborative groups. However, for the perceptually peripheral items, the emotional material aided the memory of the collaborative groups and not the individuals.



## INTRODUCTION

**Collaborative Memory**

Investigation into the effects of group remembering has yielded mixed results (Rajaram, 2011; Rajaram & Periera-Pasarin, 2010; Henkel & Rajaram, 2011; Barber, Rajaram, & Aron, 2010). Depending on how memory performance was calculated, collaborative recall was either superior or inferior to isolated recall (Wright & Klumpp, 2004). Weldon, Blair, & Huesbch (2000) argued that instead of average correct recall, the number of unique correct items was the better estimate of memory. Employing that measure, they conducted five different experiments in which participants tried to remember a list of words either individually, and their answers were later grouped when scored (thus creating nominal groups) or in a collaborative group. They found that regardless of strategy (forcing answers, accountability of answers, monetary rewards), the collaborative groups were inferior to the nominal (or individual) groups (Weldon, Blair, & Huebsch, 2000). The authors proposed a variety of theories to account for this effect, ranging from disruption of the individual's retrieval strategies while in a group, group participation producing instances of production blocking as well as social loafing (Weldon, Blair, & Huebsch, 2000). The authors finally concluded that overall amount recalled goes up with group size but fewer unique correct items result, which they called collaborative inhibition (Weldon, Blair & Huebsch, 2000). However, in these studies, the participants that remembered alone were each given their own questionnaire, while the group was simply given one questionnaire for the entire group. Thus, the individuals had more opportunities to recall information and thus the collaborative group were handicapped by an artifact of the testing procedure.

Two recent studies (McClure, Atkinson & Bohannon, 2010; Atkinson, Jennings & Bohannon, 2011) examined the Weldon et al. (2000) measurement assumptions in more detail. In these studies, more than 300 subjects viewed a slideshow presentation and then answered both probed and free recall questionnaires either individually, in a traditional collaborative group, or in a third type of collaborative group in which the individuals contributed individually at first, and then discussed their answers to choose one as a group (the equal chance group) (McClure, Atkinson & Bohannon, 2010). The nominal group's and the collaborative group's scores were similar to those found in Weldon et al. (2000). However, for the equal chance group, they showed unique correct scores that were superior to the nominal group, thus showing that the collaborative inhibition effect is an artifact of the measurement procedure (McClure, Atkinson & Bohannon, 2010). The grouped recall effect is due to grouped individuals having idiosyncratic memory details to share in the group recollection. Although the other people in the group failed to recollect that item, the success of one member contributes that item to the grouped performance. Similarly, different unique correct items are contributed by all the other members of the group, thus raising the average of group recall over isolated recall. Similar effects were also found in other previous research (Rajaram & Periera-Pasarin, 2007), however the authors in that study attributed the group superiority to a minimization of retrieval disruption which was thought to be a primary cause of CI.

Thus while older studies showed that collaborative groups recalled less than nominal groups, more recent investigations have shown that these results may have been due to a measurement artifact, and not an actual memory effect. This has led to a theoretical model for how collaborative memory works (Figure 1). In this model, person



Person 1 and person 2 each remember some unique parts of the TBR (to-be-remembered) material. At the same time, there is also some overlap between the two memories that leads to both people remembering some of the same things. Therefore, while some overlap is evident, each person also makes their own individual contributions.

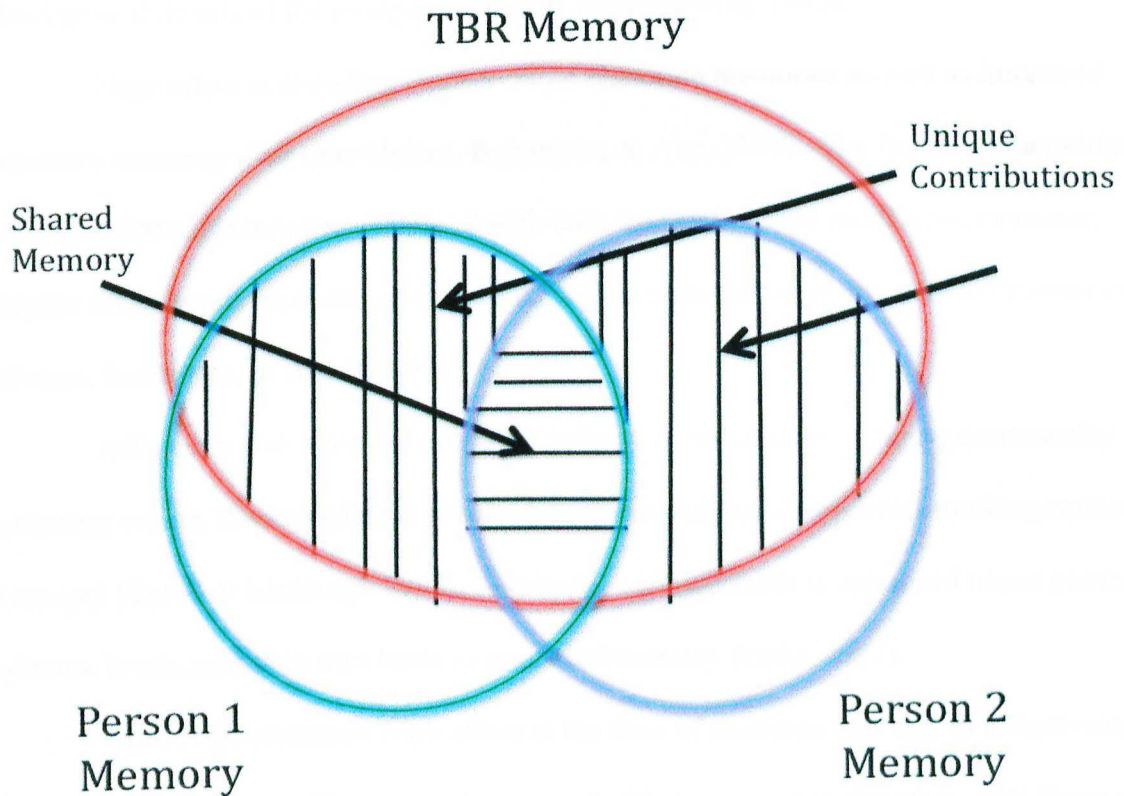


Figure 1: Memory Model Under Non-Emotional Conditions

### **Affect**

Arousal at the time of memory encoding can cause you to remember more.

Bohannon, Gratz, and Cross (2007) examined over 2000 subjects' flashbulb memories of traumatic events at delays of 2 weeks to 50 years from the event itself. Affect levels were

measured as either calm or upset during the event, and those that had higher affect at the time of encoding had more elaborate and detailed memories. Similarly, Libkuman et al. (1999) had 286 students participate in three separate experiments where they were measured on both physiological and emotional arousal, and then performed a memory task. They found that emotional arousal helped to enhance memory for both central and background details of the recognition task (Libkuman et al, 1999).

High affect at encoding leads to more elaborate memories as well as improved memory accuracy over time (Julian, Bohannon, & Aue, 2009). The flashbulb memories of over 1700 subjects were examined with both free and probed recall questionnaires; higher affect levels were shown to be linked with more elaborate and detailed memories (Julian, Bohannon, & Aue 2009).

Affect can also have physiological influences on memory. During emotionally arousing events, the amygdala is involved in the formation of improved autobiographical memory (Cahill & McGaugh 1998). Similarly, emotion leads to enhanced blood plasma glucose levels, which in turn leads to improved memory (Gold, 1987).

However, extremely high affect at the time of encoding can lead to a narrowing of remembered events. This “tunnel memory” effect causes participants to only focus on certain elements of their memories and to forget others (Safer, et al., 1998). In this study, the experimenters showed participants either an emotionally traumatic slide or a neutral slide (Safer, et al., 1998). Subjects that viewed the traumatic slides showed a perceptual narrowing of their memory for the critical slide when compared to the subjects that viewed the neutral slides (Safer, et al., 1998). The subjects that viewed the traumatic slide focused all of their attention on the center of the slide and thus didn’t remember

very many of the peripheral information when compared to those that viewed the neutral slides. Thus, affect has been shown to enhance memory in some traumatic situations, but it has also been shown to be a hindrance in others.

### **Theoretical Approach for How Affect Works on Groups**

Despite the superiority of group recall, there are other aspects of group memory that have yet to be evaluated. More specifically, how shared arousing events can influence two people to remember things similarly, or differently. Thus the effect of affect might work in grouped recollection in an interesting way. Suppose that all members of the group, due to the arousing nature of the material, only focus on and recall the emotional elements, thus reducing the idiosyncratic contributions that are at the core of the grouped memory advantage. In the case of our model, the individuals memories' will overlap more and each individual will have fewer unique contributions (Figure 2). If the "tunnel memory" hypothesis is correct, then groups recalling emotional vs. neutral events should have little advantage over isolated subjects, whereas recalling neutral material should show a clear group superiority.



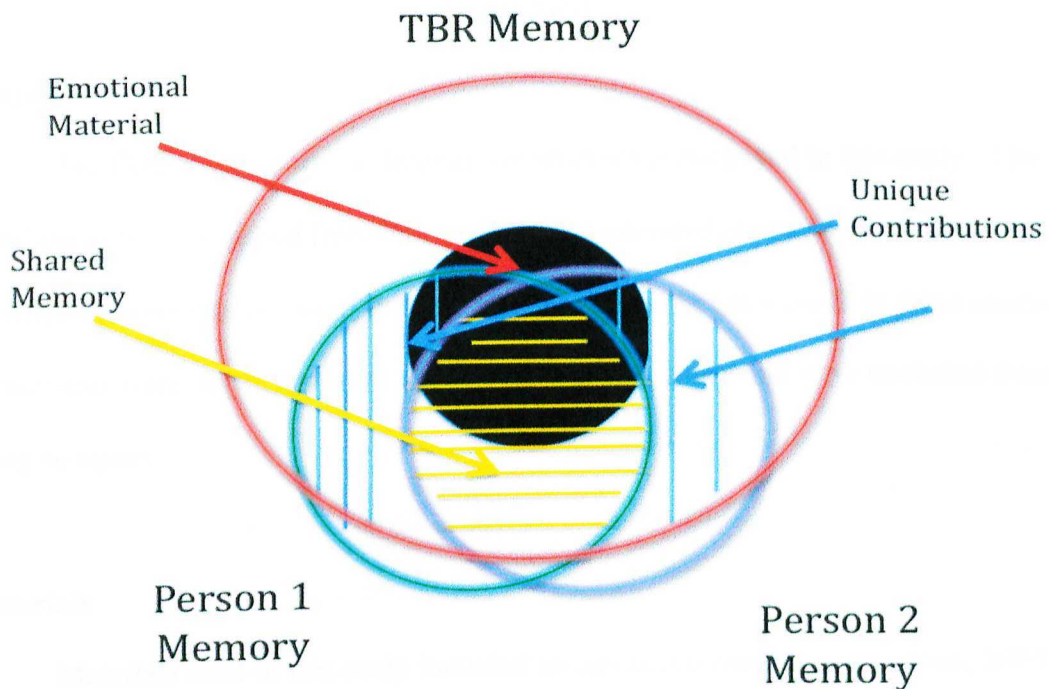


Figure 2: Memory Model Under Emotional Conditions

Hypothesis:

- 1). If people experience the same thing, then recalling in groups will be superior to recalling in isolation. If the number of answers produced by collaborative groups and isolated individuals are equivalent, groups will be superior regardless of memory measure.
- 2). If emotions contract either your perceptual search, or your cognitive processing during encoding, then emotion should reduce the superiority of collaborative groups in recall. If tunnel memory is a perceptual process, more akin to tunnel vision, then the collaborative reduction should be greatest in the peripheral information. If tunnel memory is a cognitive process, then the effect should reduce the collaborative advantage in the a-thematic, contextually irrelevant information as well.

## METHOD

### Subjects

342 Butler University undergraduate students participated in this study. The participants were recruited from introductory and intermediate psychology courses. Participants were compensated for their time by receiving extra credit in these courses. Participants were only allowed to take part in the study once and were excluded from doing so again.

### Materials

Materials used in this study included an emotional matrix survey (Eich, 2007), free recall questionnaire and probed recall questionnaire. The emotional matrix survey consists of a nine by nine square grid with scales from extremely unpleasant to extremely pleasant and extremely high arousal to extremely low arousal (Appendix A). The free recall questionnaire consisted of a sheet of paper with 20 blank lines for each critical slide (3 sheets total) for the participants to write down as many items that they could recall (Appendix B). The probed recall questionnaire consisted of 24 recall and recognition questions (Appendix C & D). There were 8 questions from each critical slide. There were two versions of the questionnaire to counterbalance the recall and recognition questions. Half of the questions from each slide pertained to perceptually central items and half pertained to perceptually peripheral items. Half of the questions from each slide were also about contextually relevant items and half were about contextually irrelevant items. Additionally, confidence ratings, on a scale from one to five, were assessed for each answer on the probed recall questionnaire.



## Procedure

All participants were block randomized to either the emotional or non-emotional condition; all participants that showed up at a given time were either shown the emotional or non-emotional version (e.g., all participants that showed up at 6pm on Thursday were shown the emotional version). When participants arrived, informed consent was obtained and all participants were reminded that they could opt out of the study at any time if any of the potentially graphic images upset them. After informed consent was obtained, participants were given an emotional matrix survey to gauge their emotional state preceding the slideshow. Participants then watched a three minute fifteen second narrated slide show about a tour through a house. All slides were shown for five seconds each preceded by a five second descriptive slide and followed by a five second blank slide. During the blank screen delay, a short narrative describing the next scene was read. The critical slides (breakfast, lunch preparation, and bathroom (see appendices E – H)) were the three slides at the middle of the fifteen slide presentation. For the emotional version of the presentation, the critical lunch preparation slide had a man slicing off some fingers and was followed by three ER photos (exploded face, severed hand and a foot with several toes cut off). For the non-emotional presentation, the critical lunch preparation scene had a man slicing bread and was followed by three slides of assorted food items.

After the slideshow, participants filled out another emotional matrix survey to assess their emotional state following the slideshow. Participants were then given a 10-minute distracter task, a word search puzzle. After that 10-minute period, participants

answered two questionnaires (free recall and probed recall) in one of two ways. One group of participants answered the questionnaire in isolation with no collaboration at all. Another group of students was divided into groups of three and answered the questionnaires collaboratively. Participants were told to answer as much as they could, and not to guess, therefore eliminating forced answers.

### Scoring

For the emotional matrix measure, scores were assigned from how far they were from the middle of the matrix, with scores on both measures being ranged from negative three to positive three. Scores were measured before and after the slideshow and the differences between the two were later analyzed.

For the free recall questionnaire, answers were scored for overall correctness, unique correctness, perceptual centrality, and contextual relevance. Questionnaires were assessed for the total number of correct answers, as well as for the total number of uniquely correct answers, scored as 1 for correct and 0 for incorrect. For the collaborative groups, these two answers were the same, for the nominal groups, these numbers could be different because answers that repeated across participants were only counted once. Answers were also scored on the basis of perceptual centrality (whether they were located in the center of the slide, or the periphery) and contextual relevance (whether the item was contextually relevant to the scene or not). Finally, in order to account for discrepancies in the number of answers between collaborative groups and nominal groups, the data were yoked such that the nominal groups were restricted to the same number of responses as the collaborative groups. Therefore, however many



answers that they collaborative groups came up with, the nominal groups were limited to that same number of answers. Each collaborative group was randomly matched with a corresponding nominal group for this process.

For the probed recall questionnaires, answers were also scored for overall correctness, unique correctness, perceptual centrality, contextual relevance, and confidence. For both the collaborative and nominal groups, overall correctness of answers was assessed and scored as a 0 for incorrect and 1 for correct. Additionally, scores were also assessed for unique correctness. Collaborative groups only had one protocol for the group and thus, their answers were scored as 1 for correct and 0 for incorrect. However, for the nominal groups, if one of the three members got the answer correct, then the whole group was credited as having got the item uniquely correct with 1 for correct and 0 for incorrect. Answers were also assessed for overall correctness of perceptual centrality and contextual relevance. Finally, confidence ratings were assessed for each person in the nominal condition, or each group in the collaborative condition.

For all subjective scores, inter rater reliability tests were performed between scorers and inter rater reliability exceeded 90%.

## RESULTS

To test the effect of collaboration and support the artifactual nature of collaborative inhibition in free recall, the total memory scores were analyzed with a 2 recall group (isolated vs. collaborative) x 2 condition (unyoked vs. yoked) repeated measure ANOVA. Both recall group and condition were between subjects variables. Recall that yoking is a procedure to make a randomly selected group of isolated subjects have the same (yoked) number of responses as a randomly selected collaborative group. The unyoked condition allows isolated rememberers to have significantly more free recall responses than the collaborative groups. We found a significant main effect of condition,  $F(1,110) = 281.7, p < .001$ ; however there was no main effect for recall group,  $F(1,110) = .212, p < .646$ . Even though there was no main effect for recall group, that was expected because that analysis was collapsing the yoked and unyoked groups together. There was a significant interaction such that groups recalled more accurate items than isolated subjects when the total number recalled was equivalent (yoked),  $F(1,110) = 254.1, p < .001$  (Figure 3). However, when isolated subjects were allowed to have more answers than the groups, isolates were superior.

To analyze this same effect in probed recall, a 3 slide (breakfast vs. lunch vs. bathroom) x 2 recall group repeated measures ANOVA was performed. Significant main effects of slide,  $F(2,416) = 3.815, p < .023$ , and recall group were found,  $F(1,208) = 33.63, p < .001$ . We also found an interaction such that collaborative groups remembered more than the nominal groups on each of the three critical slides,  $F(2,416) = 5.78, p < .003$  (Figure 4). Therefore, in both probed and yoked free recall, collaborative groups

were superior to nominal groups. The only time that nominal groups were superior to collaborative groups and the CI effect was found was in unyoked free recall.

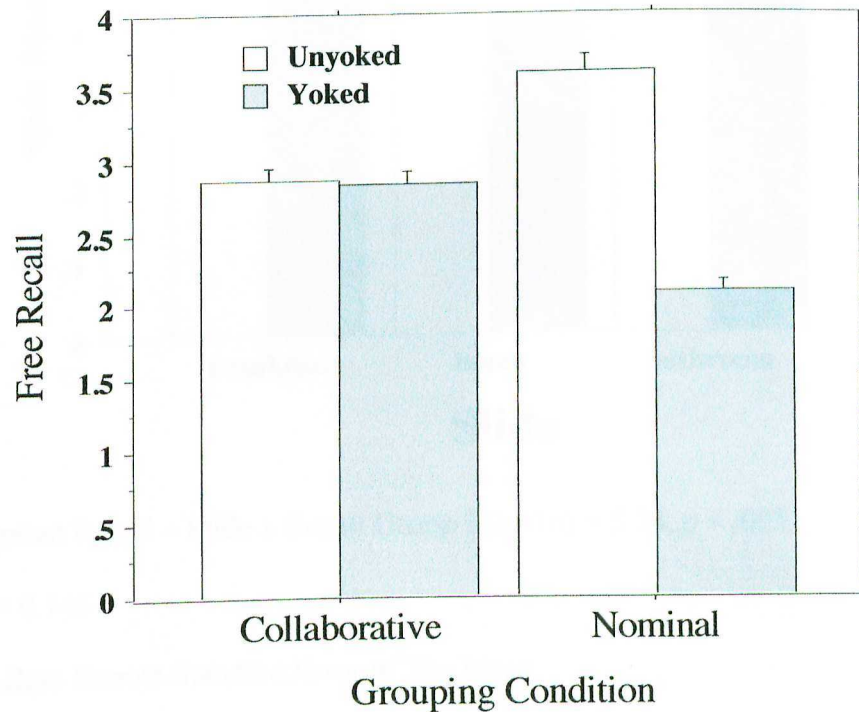


Figure 3: Free Recall – Recall Group x Condition  $F(1,110) = 254.1, p < .001$

Cohen's  $f^2 = 1.49$

Note: Error Bars Denote Standard Error of The Mean



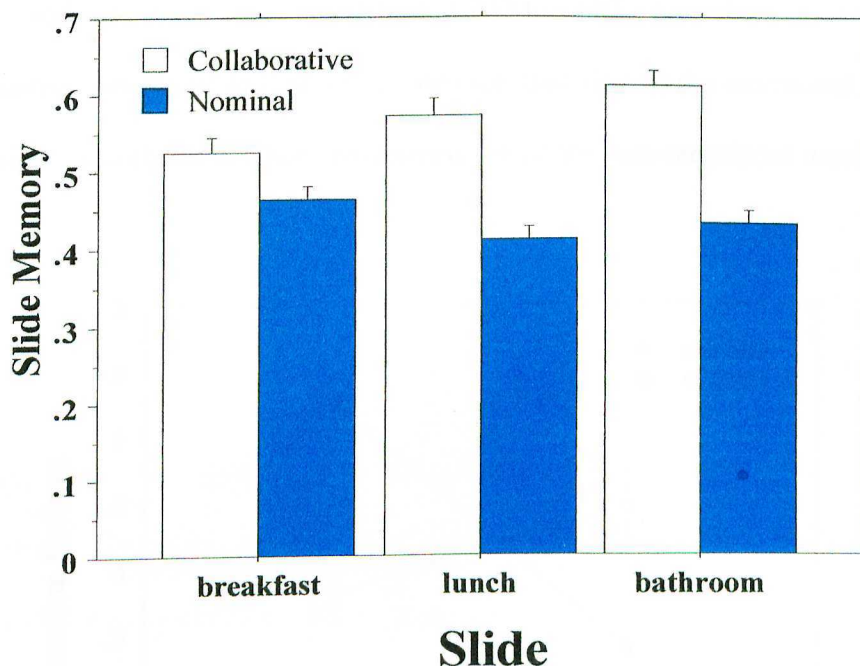


Figure 4: Probed Recall – Slide x Recall Group  $F(2,416) = 5.78, p < .003$

Cohen's  $f^2 = 0.145$

Note: Error Bars Denote Standard Error of The Mean

To see if we actually induced any emotional arousal in our subjects that viewed the emotional material, we performed a 2 type of emotion (arousal vs. valence) x 2 time of rating (pre-slide vs. post-slide) repeated measures ANOVA; both variables were within subjects. There was no significant main effect of type of emotion,  $F(1,55) = .437, p < .511$ . However that was expected since that analysis collapsed across pre-slideshow and post-slideshow viewings. There was a main effect of time of rating,  $F(1,55) = 11.95, p < .001$ . There was also a significant interaction such that arousal increased after viewing the slideshow whereas valence (feelings of pleasantness) decreased,  $F(1,55) = 41.6, p < .001$  (Figure 5). After the subjects viewed the emotional slideshow, arousal increased

from  $-.179$  to  $.464$  and valence decreased from  $1.232$  to  $-.607$ . This showed us that we did actually induce emotional arousal in our subjects that viewed the emotional material. No such manipulation check has been performed yet on the non-emotional material.

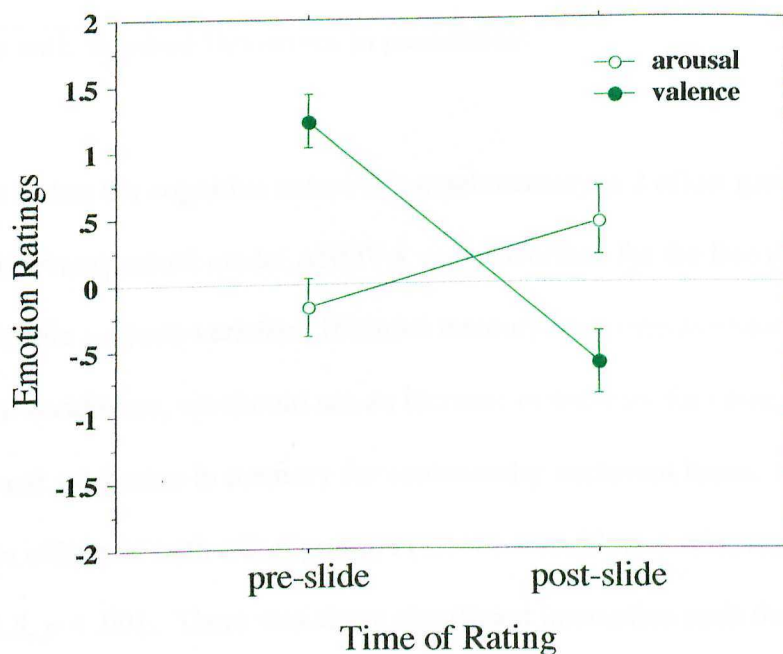


Figure 5: Type of Emotion x Time of Rating  $F(1,55) = 41.6, p < .001$

Cohen's  $f^2 = 0.851$

Note: Error Bars Denote Standard Error of The Mean

To test the overall effect of affect on memory, we performed 2 affect x 2 condition repeated measures ANOVA for free recall, and a separate 2 affect one way ANOVA for probed recall. We found a main effect of affect in both free recall,  $F(1,110) = 13.09, p < .001$ , and probed recall,  $F(1,208) = 4.77, p < .03$  (Table 1). Emotion had an overall agonistic effect on memory. Under emotional conditions, memory was improved in both probed and free recall.



Table 1: Main Effect of Affect

Variable	Emotional	Non-Emotional	Significance	Effect Size: Cohen's $f^2$
Free Recall	6.03 (2.33)*	5.34 (1.97)*	$F(1,110) = 13.09,$ $p < .001$	0.326
Probed Recall	12.91 (7.62)*	11.26(6.14)*	$F(1,208) = 4.77,$ $p < .03$	0.128

\*Means with Standard Deviations in parentheses

In order to test the cognitive nature of tunnel memory, a 2 affect group x 2 context (relevant vs. irrelevant) mixed model ANOVA was performed for the free recall data; context was a within subjects variable. If tunnel memory is a cognitive process, then under emotional conditions, we should see an increase in memory for contextually relevant items and a decrease in memory for contextually irrelevant items. There were significant main effects of both affect group,  $F(1,110) = 15.23, p < .001$ , and context  $F(1,110) = 622.5, p < .001$ . There was also a significant interaction such that participants in the emotional condition recalled more context irrelevant items than those in the non-emotional condition, with no difference in the context relevant items,  $F(1,110) = 50.8, p < .001$  (Figure 6). The same effect was found not to be significant in the probed recall data,  $F(1,211) = 2.314, p < .130$ . However, 2 context x 2 recall group mixed model ANOVA was performed for the probed recall data. There was a significant main effect for recall group,  $F(1,211) = 50.4, p < .001$ , but not for context,  $F(1,211) = 2.451, p < .119$ . An interaction was found such that collaborative groups remembered significantly more context relevant and context irrelevant information than the nominal groups,  $F(1,211) = 12.43, p < .001$  (Figure 7). These results show that the emotional condition in free recall and the collaborative condition in probed recall remembered more context irrelevant

items than context relevant items, arguing against tunnel memory being a cognitive process.

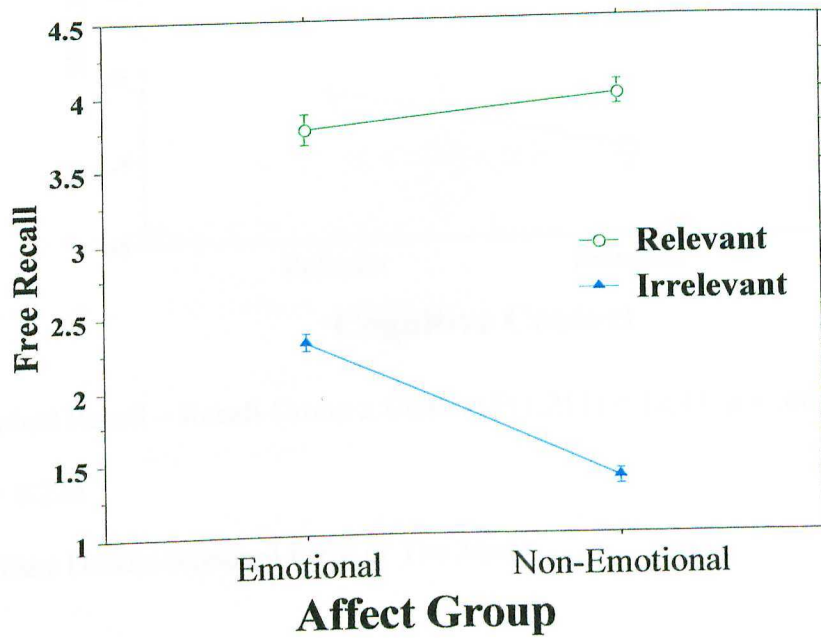


Figure 6: Free Recall – Affect Group x Context  $F(1,110) = 50.8, p < .001$

Cohen's  $f^2 = 0.661$

Note: Error Bars Denote Standard Error of The Mean

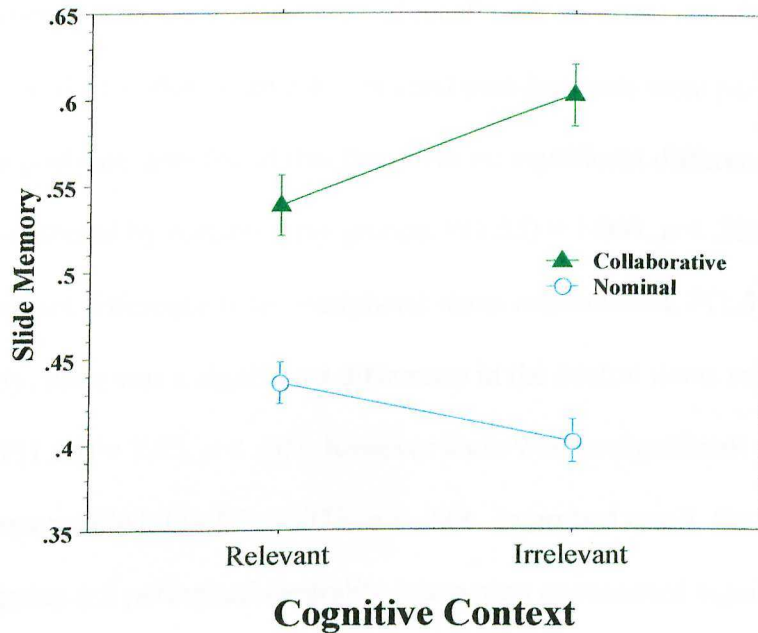


Figure 7: Probed Recall – Recall Group  $\times$  Context  $F(1,211) = 12.43, p < .001$

Cohen's  $f^2 = 0.224$

Note: Error Bars Denote Standard Error of The Mean

Finally, we tested to see if tunnel memory is a perceptual process more akin to tunnel vision. If tunnel memory is a perceptual process then under emotional conditions, we should see an increase in memory for perceptually central items and a decrease in memory for perceptually peripheral items. In free recall, a 2 recall group  $\times$  2 affect group (emotional vs. non-emotional)  $\times$  2 perceptual centrality (central vs. peripheral) mixed model ANOVA was performed; perceptual centrality was a within subjects variable. Significant main effects were found in both affect group,  $F(1,110) = 15.19, p < .001$ , and perceptual centrality,  $F(1,110) = 380.1, p < .001$ . However, there was no significant main effect of recall group,  $F(1,110) = .010, p < .922$ . Arousal allowed the isolates to improve their recall of central items with no effect on the groups' superior recall, whereas arousal



improved the accuracy of the groups' peripheral recall with no effect on isolates' poor recall,  $F(1,110) = 8.31, p < .004$  (Figure 8). Several post-hoc tests were performed on this data set. The post-hoc tests found that there was no significant difference in the central items remembered by collaborative groups,  $F(1,55) = 1.009, p < .320$ ; however there was a significant difference in the peripheral items remembered,  $F(1,55) = 13.1, p < .001$ . Additionally, there was a significant difference in the central items recalled by nominal groups,  $F(1,55) = 7.75, p < .007$ ; however there was no significant difference in the peripheral items recalled,  $F(1,55) = .075, p < .789$ . In probed recall, the same 2 recall group x 2 affect group x 2 perceptual centrality interaction approached significance, but unfortunately did not meet our required alpha level,  $F(1,211) F = 3.580, p < .059$ . Nonetheless, in free recall, collaborative groups remembered more perceptually peripheral items than nominal groups, again arguing against tunnel memory being a perceptual process.

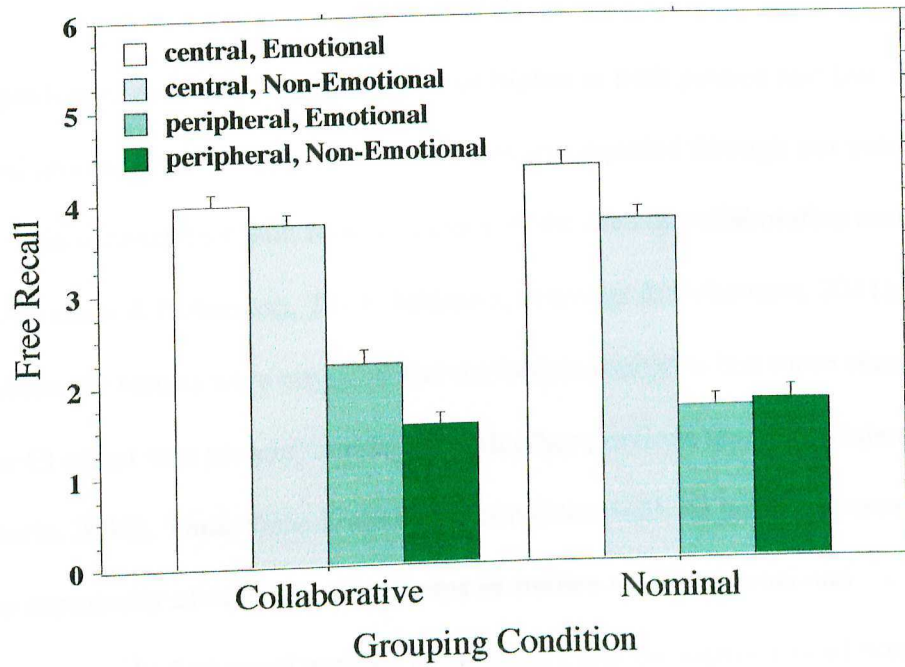


Figure 8: Free Recall – Recall Group x Affect Group x Perceptual Centrality  $F(1,110) = 8.31, p < .004$ . Cohen's  $f^2 = 0.253$

Note: Error Bars Denote Standard Error of The Mean

## DISCUSSION

As predicted, collaborative groups scored higher in both probed and free recall than nominal groups when the number of responses was equated through our yoking procedure. This is consistent with recent research in the area of collaborative memory (McClure, Atkinson & Bohannon, 2010; Atkinson, Jennings & Bohannon, 2011). However, when the results were unyoked and the isolated subjects had more chances to respond, the CI effect was present, consistent with other previous research (Rajaram & Periera-Pasarin, 2010). Thus, these findings are consistent with all previous research showing the superiority of collaborative groups in studies where nominal and collaborative groups had an equal number of responses and the superiority of nominal groups when the isolates had more chances to respond. Overall, these results show that CI remains a myth and should be discarded. The yoking procedure eliminates CI in free recall and shows that collaboration is not an antagonist of memory, but rather an agonist.

The question remains, however: where is the collaborative advantage? The accepted model (Figure 1) predicts that the collaborative advantage (CA) would be greatest in the information that is difficult to process and most likely recalled by a single member of the groups. There was an interaction between context and recall group (Figure 7). The collaborative groups remembered more overall than the isolated participants. However, the greatest CA occurred for the difficult, contextually irrelevant information (e.g., a crayon on the breakfast table). This lends further support to hypothesis 1 in that collaboration helps to significantly improve memory

We found that we were able to induce arousal in our subjects that viewed the emotional material. Figure 5 shows the increase in arousal and the simultaneous decrease



in valence. Therefore, the emotional slides had the desired effect increasing arousal, specifically of an aversive type. When that arousal was induced, emotion was found to have a general agonistic effect on memory. In both probed and free recall, those subjects that saw the emotionally arousing material had superior memory to those that didn't. Participants that viewed the emotional slideshow remembered 13% more material than those that didn't (see Table 1). Therefore, regardless of what type of question is asked (e.g. "tell me all you remember" – free recall, or "what color was the crayon" – probed recall), emotion confers a memory advantage. Nonetheless, police officers separate aroused witnesses as standard procedure on the assumption that collaborative recall will distort memory (Loftus & Ketcham 1991). We found evidence that supports the exact opposite. Arousal not only improves memory for individuals, but for collaborative groups as well. Therefore, as a practical application of this research, police officers shouldn't separate aroused witnesses as we have shown that emotional arousal, and working collaboratively both help to improve memory for emotionally charged material.

The second hypothesis about emotion and tunnel memory was investigated several ways. If the effect of emotion is to narrow either conceptual processing or perceptual fields, then our contextually relevant and perceptually central information should be enhanced whereas the contextually irrelevant and perceptually peripheral information should suffer in memory. Further, we should find this effect in both collaborative and nominal groups. We found some evidence for this effect in the perceptual free recall results of the nominal groups (Figure 8). Those individuals in the emotional condition showed an increase in the number of central items recalled, with no



difference between emotional and non-emotional conditions for number of peripheral items recalled. However, this was the only support that we found for this hypothesis.

When examining cognitively relevant and irrelevant results in free recall, there was no evidence of this tunnel memory effect due to emotion. There was no free recall difference in the context relevant information between the emotional and non-emotional conditions. Worse yet for the fate of the cognitive tunneling hypothesis, there is evidence of the exact opposite effect. Arousal caused increased free recall for the context irrelevant information (Figure 6). In the probed recall data, there was no significant interaction between context and affect. At least for free recall, high affect at the time of encoding increased subjects' memory for contextually irrelevant information, which suggests a widening of memory, not a narrowing.

Analysis of perceptual results showed there was no difference in central items free recalled by collaborative groups between emotional and non-emotional conditions. However, there was a difference in peripheral items; in the emotional condition, the collaborative groups recalled significantly more peripheral items than those collaborative groups in the non-emotional condition (Figure 8). We also noted that even though the group superiority effect wasn't present in cognitive relevance or perceptual centrality, this analysis was done across both yoked and unyoked conditions, which accounts for the lack of group superiority (Figure 3). In free recall, we saw increased recall of perceptually peripheral items by collaborative groups under emotional conditions, with no differences in perceptually central items. Therefore, this leads us to believe that tunnel memory is neither a cognitive process nor a perceptual process as the recall of perceptually peripheral or contextually irrelevant information increased under emotional

conditions. Even though a tunnel memory effect was present for nominal groups (Figure 8), whatever tunnel memory existed was wiped out under collaborative conditions.

So is there a special memory mechanism for emotional material? Schmidt (2008) argued that there isn't. According to Schmidt, a person has a certain amount of cognitive resources to use for memory. When memory for one thing is improved, another area is inhibited; this was his explanation for the Von Restorff effect (Schmidt 2008). If that were the case, then as memory for perceptually central items was improved, we should see an inhibition in the perceptually peripheral items or vice versa. Similarly, as memory improved for contextually irrelevant items, memory for contextually relevant items should also suffer proportionally. However, we found the exact opposite. When examining both perceptual centrality and cognitive centrality (relevance) we found evidence for a special memory mechanism. Emotion improved memory for both perceptually peripheral items, with no change in recall of perceptually central items, whereas it also improved memory for contextually irrelevant items with no change in contextually relevant items. This argues against the idea of allocation of resources (Schmidt, 2008), and suggests that under emotional conditions we can somehow draw on additional resources to help bolster our memory.

In conclusion, we found support for Hypothesis 1; collaborative groups were superior to nominal groups in both probed and free recall when the number of answers were equivalent. This is consistent with recent research on collaborative memory (McClure, Atkinson & Bohannon, 2010; Atkinson, Jennings & Bohannon, 2011) that supports the idea that CI is an artifact of the testing procedure and not a real memory phenomenon. We also found very little support for tunnel memory, either cognitively or

perceptually. In free recall, emotion increased recall of both perceptually peripheral and contextually irrelevant items. While the tunnel memory effect was present in the free-recall nominal condition, that effect wasn't replicated in the probed data. Therefore, we argue that tunnel memory isn't a real memory phenomenon either, especially when working collaboratively.

So then what is the effect of affect on collaborative memory? We argue that emotion doesn't lead to tunnel memory, either cognitively or perceptually. In fact, our results indicate that working collaboratively when remembering emotional material increases memory both cognitively and perceptually. Emotion doesn't lead to a narrowing of memory as suggested by Christianson & Safer (1998), but rather it expands memory and subjects remember even more under emotional conditions. Therefore, emotion doesn't lead to a tunneling of memory, but rather something more akin to IMAX, where subjects not only remember the cognitively and perceptually central items, but the peripheral and irrelevant ones as well.



## REFERENCES

- Barber, S. J., Rajaram, S., & Aron, A. (2010). When two is too many: Collaborative encoding impairs memory. *Memory & Cognition*, 38(3), 255-264.
- Bohannon, J., Gratz, S. & Cross, V. (2007). The effects of affect and source on flashbulb memory. *Applied Cognitive Psychology*, 21, 1-12.
- Bohannon, J. N., & Symons, V. L. (1992). Flashbulb memories: Confidence, consistency and quantity. In Neisser, U., Winograd, E. (Eds.), *Affect and Accuracy in Recall* (pp. 19-67). New York: Cambridge University Press.
- Cahill, L., & McGaugh, J. L. (1998). Mechanisms of emotional arousal and lasting declarative memory. *Trends in Neurosciences*, 21(7), 294-299
- Eich, E., Ng, J. T. W., Macaulay, D., Percy, A. D., & Grebneva, I. (2007). Combining music with thought to change mood. In J. A. Coan & J. B. Allen (Eds.), *The handbook of emotion elicitation and assessment* (pp. 124-136). New York: Oxford University Press.
- Gold, P. (1987). Sweet memories. *American Scientist*, 75(2), 151-155.
- Henkel, L. A., & Rajaram, S. (2011, April 4). Collaborative remembering in older adults: Age-invariant outcomes in the context of episodic recall deficits. *Psychology and Aging*. Advance online publication. doi: 10.1037/a0023106
- Heuer, F., & Reisberg, D. (1990). Vivid memories of emotional events: The accuracy of remembered minutiae. *Memory & Cognition*, 18 (5), 496-506.
- Julian, M., Bohannon, J. & Aue, W. (2009). Are elaborate memories consistently accurate? In O. Luminet, M. Conway & A. Curci (Eds.). *New perspectives in flashbulb memory*. London, UK: Psychology Press.

- Libkuman, T. M., Nichols-Whitehead, P., Griffith, J., & Thomas, R. (1999). Source of arousal and memory for detail. *Memory & Cognition*, 27 (1), 166-190.
- Loftus, E. F., & Ketcham, K. (1991). *Witness for the defense: the accused, the eyewitness, and the expert who puts memory on trial*. New York: St. Martin's Press.
- Metcalf, J., & Jacobs, W. J. (1998). Emotional Memory: The effects of stress on "cool" and "hot" memory systems. In Douglas Medin (ed.). *The Psychology of Learning and Motivation: Advances in research and theory*, (pp. 187-222). San Diego, CA, US: Academic Press.
- Rajaram, S. (2011). Collaboration both hurts and helps memory: A cognitive perspective. *Current Directions in Psychological Science*, 20(2), 76-81.
- Rajaram, S., & Periera-Pasarin, L. P. (2007). Collaboration can improve individual recognition memory: Evidence from immediate and delayed tests. *Psychonomic Bulletin & Review*, 14(1), 95-100.
- Rajaram, S., & Periera-Pasarin, L. P. (2010). Collaborative memory: Cognitive research and theory. *Perspectives on Psychological Science*, 5(6), 649-663.
- Schmidt, S. (2008). Distinctiveness and memory: A theoretical and empirical review. In H.L. Roediger, III (ed.). *Cognitive Psychology of Memory. Vol. (2) of Learning and Memory: Comprehensive Reference, 4 vols.*, (pp. 125-144). Oxford: Elsevier.
- Safer, M. A., Christianson, S., Autry, M. W., & Osterlund, K. (1998). Tunnel Vision For Traumatic Events. *Applied Cognitive Psychology*, 12(2), 99-117.
- Weldon, M. S., Blair, C., & Huebsch, P. D. (2000). Group remembering: Does social loafing underlie collaborative inhibition?. *Journal of Experimental Psychology*, 26(6), 1568-1577.

Wright, D. B., & Klumpp, A. (2004). Collaborative inhibition is due to the product, not the process, of recalling in groups. *Psychonomic Bulletin & Review*, 11(6), 1080-1083

McClure, L., Atkinson, D., & Bohannon, J.N. (2010, May) Two heads are still better than one: Collaborative Inhibition is artifactual. Poster session presented at the Annual Meeting of The Association for Psychological Science, Boston, MA.

Atkinson, D., Jennings, E., & Bohannon, J.N. (2011, May) Collaborative Inhibition in free recall is artifactual: Shown two ways. Poster session presented at the Annual Meeting of The Association for Psychological Science, Washington D.C.







Appendix B: Free Recall Protocol

**Please Circle: Female/Male**

Please work as a group to recall as many items from the selected scenes as accurately and as detailed as you can remember. You do not have to provide an answer for every line.

**Breakfast Scene**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_
11. \_\_\_\_\_
12. \_\_\_\_\_
13. \_\_\_\_\_
14. \_\_\_\_\_
15. \_\_\_\_\_
16. \_\_\_\_\_
17. \_\_\_\_\_
18. \_\_\_\_\_

19. \_\_\_\_\_

20. \_\_\_\_\_

### Lunch Preparation Scene

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_
11. \_\_\_\_\_
12. \_\_\_\_\_
13. \_\_\_\_\_
14. \_\_\_\_\_
15. \_\_\_\_\_
16. \_\_\_\_\_
17. \_\_\_\_\_
18. \_\_\_\_\_
19. \_\_\_\_\_
20. \_\_\_\_\_



### Bathroom Scene

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_
11. \_\_\_\_\_
12. \_\_\_\_\_
13. \_\_\_\_\_
14. \_\_\_\_\_
15. \_\_\_\_\_
16. \_\_\_\_\_
17. \_\_\_\_\_
18. \_\_\_\_\_
19. \_\_\_\_\_
20. \_\_\_\_\_

Appendix C: Probed Recall Protocol Version A

Work as a group to answer the following questions as accurately and as detailed as you can remember. If you do not know the answer to a question, please leave that question blank.

For recognition questions, please circle only one of the provided answers

For each question, indicate your confidence using the 5-point scale below.

Confidence Scale				
1	2	3	4	5
Not at all Confident	Little Confidence	Average Confidence	Very Confident	Extremely Confident

Confidence  
Rating (1-5)

Answer the following 8 questions about the breakfast scene.

1. How many pieces of silverware were there? \_\_\_\_\_
2. What kind of cosmetic was on the table?      Eye Shadow      Lipstick      Powder Compact      \_\_\_\_\_
3. What was in the jar on the table?      Cookies      Jelly      Pickles      \_\_\_\_\_
4. What band's CD was sitting on the table? \_\_\_\_\_
5. What color was the toy car on the table?      Pink      Yellow      Blue      \_\_\_\_\_
6. How many pieces of toast were there? \_\_\_\_\_
7. What drink was being served with breakfast?      OJ      Milk      Coffee      \_\_\_\_\_
8. What tool accompanied the breakfast on the table? \_\_\_\_\_

Answer the following 8 questions about the lunch preparation scene.

9. What food item was being cut? \_\_\_\_\_
10. What brand of cigarettes was on the table? \_\_\_\_\_
11. What type of soup was there?      Chicken Noodle      Tomato      Vegetable      \_\_\_\_\_

Confidence Scale				
1	2	3	4	5
Not at all Confident	Little Confidence	Average Confidence	Very Confident	Extremely Confident

- Confidence  
Rating (1-5)
12. What vegetable was on the plate? Lettuce Carrot Onion \_\_\_\_\_
13. What type of ball was on the table? \_\_\_\_\_
14. What was in the large red box? \_\_\_\_\_
15. What color was the crayon? Red Black Orange \_\_\_\_\_
16. What type of figurine was on the table? Barbie Soldier GI Joe \_\_\_\_\_

*Answer the following 8 questions about the bathroom scene.*

17. What brand of shaving cream was on the counter? \_\_\_\_\_
18. What color was the highlighter? Blue Pink Yellow \_\_\_\_\_
19. What tool was in the sink? \_\_\_\_\_
20. How many toothbrushes were in the toothbrush holder? 0 1 2 \_\_\_\_\_
21. What color was the deodorant? \_\_\_\_\_
22. What type of knife was on the counter? Swiss Army Plastic Steak Knife \_\_\_\_\_
23. What sports equipment was in there? \_\_\_\_\_
24. What type of shampoo was on the counter? Herbal Essences Head and Shoulders Suave \_\_\_\_\_



Appendix D: Probed Recall Protocol Version B

Work as a group to answer the following questions as accurately and as detailed as you can remember. If you do not know the answer to a question, please leave that question blank.

For recognition questions, please circle only one of the provided answers

For each question, indicate your confidence using the 5-point scale below.

Confidence Scale				
1	2	3	4	5
Not at all Confident	Little Confidence	Average Confidence	Very Confident	Extremely Confident

Confidence  
Rating (1-5)

Answer the following 8 questions about the breakfast scene.

1. How many pieces of silverware were there? 1      2      3      \_\_\_\_\_
2. What kind of cosmetic was on the table? \_\_\_\_\_
3. What was in the jar on the breakfast table? \_\_\_\_\_
4. What CD was on the table?      Beach Boys      REO Speedwagon      Pearl Jam      \_\_\_\_\_
5. What color was the toy car? \_\_\_\_\_
6. How many pieces of toast were on the table?      1      2      3      \_\_\_\_\_
7. What drink was being served with breakfast? \_\_\_\_\_
8. What type of tool was there?      screwdriver      pliers      hammer      \_\_\_\_\_

Answer the following 8 questions about the lunch preparation scene.

9. What food item was being cut?      Fingers      Bread      Meat      \_\_\_\_\_
10. What brand were the cigarettes?      Kool      Camel      Marlboro      \_\_\_\_\_
11. What type of soup was on the table? \_\_\_\_\_
12. What vegetable was on the plate? \_\_\_\_\_

Confidence Scale				
1	2	3	4	5
Not at all Confident	Little Confidence	Average Confidence	Very Confident	Extremely Confident

Confidence  
Rating (1-5)

13. What type of ball was on the table?    golf    tennis    baseball    \_\_\_\_\_

14. What was in the big red box?    Crackers    PopTarts    Cereal    \_\_\_\_\_

15. What color was the crayon? \_\_\_\_\_

16. What type of figurine was on the table? \_\_\_\_\_

*Answer the following 8 questions about the bathroom scene.*

17. What brand was the shaving cream?    Edge    Barbasol    Colgate    \_\_\_\_\_

18. What color was the highlighter? \_\_\_\_\_

19. What tool was in the sink?    Hammer    Pliers    Screwdriver    \_\_\_\_\_

20. How many toothbrushes were in the toothbrush holder? \_\_\_\_\_

21. What color was the deodorant?    Blue    Pink    Green    \_\_\_\_\_

22. What type of knife was on the counter? \_\_\_\_\_

23. What type of sports equipment  
was there?    Tennis  
Racket    Baseball  
Mitt    Soccer  
Cleats    \_\_\_\_\_

24. What type of shampoo was on the counter? \_\_\_\_\_

Appendix E: Critical Breakfast Slide





Appendix F: Critical Lunch Preparation Slide (Non-Emotional Version)



Appendix G: Critical Lunch Preparation Slide (Emotional Version)





Appendix H: Critical Bathroom Slide

