Memory for committing a crime: Effects of arousal, proximity, and gender

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Few researchers have investigated the memories of active participants in an emotionally arousing crime. The present study used a mock crime paradigm to explore participant memories for a low, moderate, or highly arousing event. Forty-seven undergraduate participants committed a "theft" of an exam from a professor's office. Two weeks after the theft, participants completed a cognitive interview, recalled objects from the professor's office, and constructed a map of the route to and from the crime room. Arousal improved reports on a map recall task but no other recall indices. Although there was a general superiority of recall of proximal over distal details, arousal only infrequently interacted with proximity. Some support was found for proximity (spatial–temporal distinction) as a useful proxy for centrality. Future work will benefit from an examination of the overlap between definitions of centrality and proximity with more traditional stimuli.

Most research studies conducted on memory for crime has examined the memories of eyewitnesses, an emphasis clearly reflected in the approximately 2,000 research papers reviewed in the recent two-volume *Handbook of Eyewitness Psychology* (Toglia, Read, Ross, & Lindsay, 2007; Lindsay, Ross, Read, & Toglia, 2007). However, there is a striking paucity of work examining the criminal's recall of his or her own actions during the crime. In general, of the extant research, interest has focused on memory impairment or the loss of information observed in criminals for real and, typically, violent crimes (Kopelman, 1987; Porter, Birt, Yuille, & Hervé, 2001; Schacter, 1986) or the feigned loss of information (and claims of amnesia) concerning simulated crimes in the laboratory (Christianson & Bylin, 1999; Merckelbach, Hauer, & Rassin, 2002; van Oorsouw & Merckelbach, 2004). Other researchers have focused on criminals' distortions of responsibility for the crimes themselves (Baumeister, Stillwell, & Wotman, 1990; Kearns & Fincham, 2005; Stillwell & Baumeister, 1997). However, beyond the issues of impairment and distortion there remain many questions about perpetrators' recall.

As Read, Yuille, and Tollestrup (1992; Yuille & Tollestrup, 1990) indicated, during the investigative and adjudicative phases of the legal process suspects and defendants must recall and convey their recollec-

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tions of the target events and be subject to credibility evaluations. Indeed, a suspect's statement must be evaluated in much the same manner as that of an eyewitness to determine the veracity of the statement. For example, understanding how a perpetrator recalls his or her own actions may be critical in evaluating the credibility of admissions and confession statements, whether true or false (Kassin & Keichel, 1996; Kassin, Meissner, & Norwick, 2005; Russano, Meissner, Narchet, & Kassin, 2005). Furthermore, studying perpetrator memory for the commission of a crime also provides a unique way to examine memory for active participation in, as compared to a witnessed or passive observation of, an event. It is known that active participation tends to result in better recall of an event (Hosch & Cooper, 1982; Yuille, Davies, Gibling, Marxsen, & Porter, 1994; but see Kassin, 1984, for a contrary outcome), and this may be a potentially influential factor in the understanding of perpetrator recall.

Additional issues have arisen in the eyewitness memory literature that may be especially pertinent to the examination of perpetrator memory. For instance, the level of arousal experienced by perpetrators may be particularly relevant in the interpretation of their recall of events. That is, if a perpetrator is either highly or minimally stressed by his or her crime, recall may differ substantially (Read et al., 1992). Although level of arousal has been manipulated and measured in many eyewitness memory studies, a conclusive statement about the overall influence of arousal on memory agreeable to a wide variety of researchers has not yet been achieved (Christianson, 1992; Deffenbacher, Bornstein, Penrod, & McGorty, 2005; Reisberg & Heuer, 2007).

One established influence of arousal on memory is the finding that details directly associated with an emotional event (central details) are recalled more accurately and retained well over time, in comparison to more peripheral details as arousal increases (Berntsen, 2002; Brown, 2003; Burke, Heuer, & Reisberg, 1992; Christianson, 1992; Christianson & Loftus, 1991; Reisberg & Heuer, 2007). This effect has often been considered to be an outcome of restricted focal attention with increasing arousal, as described by Easterbrook (1959). Most typically, the definition of centrality has been based on conceptual distinctions relating either to visual attention or to the meaning of the event. However, previous definitions of centrality may have been confounded with other elements of stimuli, and therefore the relationship between arousal and centrality may not be as straightforward as it appears.

For example, Laney, Heuer, and Reisberg (2003; see also Reisberg & Heuer, 2004, 2007) distinguished between stimuli that are visually or thematically arousing. These two methods of arousal induction, they argue, can elicit emotional arousal in different ways and will result in different allocations of attention. When someone experiences emotional arousal resulting from a thematic inducement, it is through a feeling of empathy or vested interest with the stimuli. However, the authors suggested that most of the research on the impact of emotional arousal on memory has examined visually induced arousal by showing graphic pictures or disturbing images. When such pictures are presented, they visually draw the viewer to the most central elements of the stimuli. Thus, results from studies using visually arousing stimuli support the Easterbrook hypothesis of a narrowing of attention when perceiving emotionally arousing stimuli. However, this effect may be less the result of arousal itself than of the visual prominence of the graphic stimuli. The authors suggested that the narrowing pattern of recall may not be present in response to thematically arousing stimuli. To test this supposition, Laney, Campbell, Heuer, and Reisberg (2004, Study 1) examined participants' recall of thematically induced emotionally arousing slides and non–emotionally arousing slides. Laney et al. found that viewing emotionally arousing slides led to no disadvantage in the recall of peripheral details; viewers of emotionally arousing slides recalled more peripheral details than viewers of nonemotional slides. The authors concluded that narrowing of attention during thematically induced emotional events was not present and that arousal improved memory generally, not just for central details.

It is likely that the distinction between central and peripheral details may also have been confounded with the proximity (spatial and temporal) of details to the source of arousal. Indeed, in Christianson's (1992) review of memory for emotional events, a peripheral detail was defined as "information that is irrelevant or spatially peripheral to the source of the emotional arousal" (p. 291). Details that occur close in

time and space (i.e., are proximal) may also be more relevant to the event than details distal to the event, of course; however, this is not necessarily the case. For example, a perpetrator's escape route, though probably peripheral to the commission of the crime, may be very relevant (i.e., central) to investigators and to the perpetrator. Similarly, a perpetrator may take special notice of eyewitnesses to the commission of the crime, despite their lack of involvement or threat to the successful completion of the crime.

The question of overlap between central–peripheral and proximal–distal distinctions also becomes relevant when we consider situations in which there are multiple sources of emotional arousal. For example, if there is substantial overlap between centrality and spatiotemporal proximity, in a bank robbery with multiple perpetrators a question of variable responsibility between perpetrators may arise. If the perpetrators are caught, it may become important to determine whether perpetrators will be best equipped to identify the actions of fellow perpetrators closest to them or of those most prominent in the commission of the crime. Such a finding may lead to recommendations for investigative techniques in situations in which there are multiple perpetrators or multiple witnesses to a crime. There may also be implications for interpretation of confession evidence, an area of substantial interest in the media and scientific community (Kassin et al., 2005; Russano et al., 2005). Perhaps a perpetrator will clearly recall the actual commission of the crime (central or proximal information) but have poor memory for the escape route (peripheral or distal information). If this is the case, inconsistencies in statements made about distal details should not be weighted as heavily as inconsistencies made about more proximal details in evaluations of the validity of a confession or a witness statement.

In this study we explore the conceptual overlap between proximity and centrality by examining the recall of proximal and distal details under various conditions of arousal and explore whether any differences are comparable to the narrowing of attention on central compared to peripheral details with increased arousal. Although with the present design we do not attempt to disentangle meaning from proximity as it relates to centrality, we explore this question by first examining whether findings regarding the centrality of details can be replicated when centrality is defined based solely on proximity. It is the interaction between proximity and arousal that is most critical to an understanding of the conceptual distinction between similarities of proximity and centrality. To study the relationship between proximity and arousal and the resulting influence on perpetrator memory, we used the mock crime paradigm of Read et al. (1992; Yuille & Tollestrup, 1990). We operationalized the proximity of a detail by assigning it to proximal and distal categories solely on the basis of its temporal and physical (spatial) proximity to the "crime," or source of the arousal.

Given the focus of the participants' task, we expected to observe greater overall recall of proximal than distal information. We also expected that participants who experienced higher levels of arousal would demonstrate overall superior recall compared with participants at lower levels of arousal. Furthermore, if centrality is an appropriate proxy for proximity, we anticipated that there should be greater relative recall of proximal information at higher levels of arousal. Finally, gender was included as a variable on the basis of previous research indicating that men and women may differentially recall details of criminal events (Lindholm & Christianson, 1998; Yarmey & Jones, 1983). However, because previous work has not found clear results regarding the recall ability of men and women, we did not hold any specific expectations regarding gender.

EXPERIMENT

METHOD

Participants

Participants were 47 undergraduate students (22 men, 25 women) who received course credit for participation. Participants were randomly assigned to same- or opposite-sex pairs and to serve as either a perpetrator of a crime or an accomplice. The participant designated as the criminal was instructed to commit the theft, and the accomplice was instructed to accompany and watch the criminal throughout all aspects of the crime but not to speak or provide any assistance.[1] Because some participants failed to attend their scheduled appointments, three participants took part in the experiment independently. This resulted in 6 female pairs (26%), 5 male pairs (21%), 6 female criminal–male accomplice pairs (26%), and

5 male criminal–female accomplice pairs (21%). No participant refused to participate or withdrew from the study.

Design

The experiment was a 3 × 2 × 2 mixed factorial design with arousal (low, moderate, high) and gender (male, female) as between-participant variables and proximity of information (proximal, distal) as a within-participant variable. All information that pertained to approaching or leaving the crime room was categorized as distal, and all information pertaining to time spent in the crime room was considered proximal.

Materials

To assess levels of arousal, participants' heart rate and blood pressure (systolic and diastolic) were taken four times: before the crime instructions, after the crime instructions, after the commission of the crime, and 2 weeks later at the follow-up interview.

The state anxiety version of the State–Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) was administered to participants when other arousal measures were taken (excluding the initial test). The STAI is a 20-item self-report measure designed to assess anxiety. There were no significant differences in the STAI scores across arousal conditions (Table 1): after crime instructions, $F(2, 46) = 1.78$, $p = .18$; after crime, $F(2, 46) = 0.57$, $p = .57$. It may be that participants were hesitant to admit that a mock crime aroused them as much as the physiological measures indicated. As a result, the STAI will not be discussed further.

Procedure

Participants were instructed to play the role of a thief in the theft of an electronic version of an exam from a professor's computer in an office. The instructions emphasized the importance of not getting caught and committing the theft in a realistic manner (i.e.,

TABLE 1. Mean (*SD*) blood pressure and heart rate

	Arousal		
	Low	**Moderate**	**High**
Before crime instructions			
Systolic BP	126.60 (15.83)	126.14 (10.71)	129.27 (17.16)
Diastolic BP	77.53 (11.58)	79.29 (9.45)	77.80 (16.00)
Heart rate	70.20 (12.34)	73.43 (9.35)	80.87 (22.89)
After crime instructions			
Systolic BP	126.20 (16.13)	124.56 (17.50)	126.27 (15.26)
Diastolic BP	78.40 (8.95)	72.31 (10.36)	76.40 (12.38)
Heart rate	69.87 (14.31)	74.94 (7.31)	84.93 (18.54)
STAI	45.88 (3.88)	43.25 (3.94)	44.47 (4.02)
After crime			
Systolic BP	127.00 (14.72)	122.38 (18.97)	140.33 (14.44)
Diastolic BP	84.38 (17.82)	74.94 (7.31)	88.40 (15.77)
Heart rate	73.63 (16.40)	78.06 (12.25)	86.93 (17.47)
STAI	42.75 (5.30)	40.69 (5.10)	41.73 (6.07)
Interview			
Systolic BP	125.50 (15.63)	119.63 (19.71)	126.07 (19.40)
Diastolic BP	76.19 (13.32)	76.19 (23.69)	74.33 (13.36)
Heart rate	72.13 (13.74)	69.13 (15.03)	77.87 (10.10)

Note. *BP = blood pressure; STAI = State–Trait Anxiety Inventory (Spielberger et al., 1970).*

as though they were stealing the exam for their own purposes). Participants were provided with a map and instructed to navigate their way to the empty professor's office (approximately a 250-m distance including two hallways and four floors by elevator) in a manner that would not call attention to themselves, knock, gain access to the room, locate a computer disk hidden in a coat pocket, open the file, read the exam, save it to a disk, and take the disk to another research area designated on the map. Participants were informed that there would be a subsequent memory test. A research assistant observed participants through a one-way mirror in the room adjacent to the professor's office to ensure that participants carried out the task as instructed.

To manipulate arousal, instructions and the setup of the professor's office were varied. In the low-arousal condition, participants were informed that the intent of the task was to work out the logistics for future participants, that there was no danger of being caught, and that they should ignore any knock on the professor's door. In the moderate-arousal condition, participants were told they had 10 min to complete the theft, anyone who knocked on the door was probably a student, and they should tell the student the professor was out of the office. In addition, the computer was rigged to make a noise and display an error message when the criminal attempted to retrieve the disk after reading the exam. In the high-arousal condition, participants were informed that people in the building were unaware of the study, and several thefts had occurred recently, causing staff to be suspicious of strangers. Participants were told that they had 6 min to complete the theft and that a knock on the door was probably a security officer, in which case they must open the door and provide an explanation for their presence in the professor's office to avoid being detained. This knock never occurred; this instruction was intended only to increase the arousal of participants. Furthermore, the computer was rigged to display an error message of a longer duration, and the crime room was rigged so that several soft drink cans fell off a bookshelf once the disk was retrieved from the coat pocket. Despite different instructions regarding the time period, participants were allowed as much time as needed to commit the crime, and all did so successfully. It was emphasized to participants that they were to *play the role* of a criminal. Finally, participants were asked not to discuss the nature of their participation with others, in order to avoid contamination of the participant pool.

Participants returned approximately 2 weeks later and participated in a version of the Cognitive Interview about the event (as per Read et al., 1992). The interview involved asking participants to reinstate the context, provide a free narrative from their own perspective, and recall the event from a different perspective (i.e., the opposite role), using a standard set of interview instructions.[2] Finally, participants were instructed to draw a map of the crime route and the crime scene and to place as many objects and spatial features on it as they could recall. All participants were thoroughly debriefed, encouraged to discuss their reactions with researchers if they desired, and provided with counseling information. No participants indicated experiencing discomfort as a result of their participation in the study. Ethical approval was obtained by the institutional review board before the start of the study.

Dependent measures

Dependent measures were categorized into one of two domains: recall accuracy and metacognitive remembrances. To assess recall accuracy, participants completed two tasks: Participants designated features on their creation of a map to and from the crime room, and there was a simple count of all accurate objects encountered during the crime as reported by participants. To examine metacognitive remembrances, we conducted a structured coding of participants' recall during the Cognitive Interview.

Recall accuracy

MAPS.

Participants' maps were scored for 32 critical details: 16 proximal (in the office) and 16 distal (to and from the office); in each category were 8 objects and 8 features of the spatial layout. Each critical detail was scored as present or absent, and a total score was calculated.

INTERVIEW OBJECTS.

Before data collection commenced, a comprehensive list of all objects available to the participants in the crime office was compiled ($N = 210$). Participants' interviews were scored for the number of these objects that were reported.

Metacognitive remembrances

NARRATIVE CODING.

Participants' narratives from the Cognitive Interview were scored using an adaptation of Fivush,

Hazzard, McDermott Sales, Sarfati, and Brown's (2003) narrative coding protocol. Coders carefully examined the narrative and conducted a simple frequency count for the presence of words uttered that were relevant to or descriptive of each of the following eight conceptual categories: *action/activity* (action or activity), *description* (adjective, adverb, or modifier), *emotion* (comments about the emotional state of the speaker or other participants), *cognition* (comments about thoughts or beliefs about the speaker or other participants), *location* (specific places or locations), *object* (objects present during the event), *person* (comments mentioning any person other than the speaker who participated in the event), and *temporal* (comments about the time the event occurred). Because of poor interrater reliability, we omitted the *action/activity* and *description* categories from further analyses. Interrater reliability (ICC_1) conducted on a subset of narratives (14%, $n = 6$) for the remaining categories ranged from good to excellent, according to guidelines reported by Cicchetti and Sparrow (1981),[3] when examined across proximal and distal codings: .79 for emotion, .79 for cognition, .82 for location, .96 for object, .75 for person, and .69 for temporal. The assumption underlying the coding of the narratives in this manner was that the number of words spoken by participants relevant to each conceptual category would reflect their foci of attention during the task. Importantly, because many of the words and phrases assigned to categories were not confirmable (e.g., cognitions, emotions, subtle actions), it was not possible to assess the accuracy of their comments. Narratives were first partitioned into proximal (i.e., in the crime room) and distal (i.e., approaching and leaving the crime room) components and their contents coded according to the criteria described earlier.

RESULTS

Manipulation checks

To assess the effectiveness of the arousal manipulation, we compared the measurements of blood pressure and heart rate across arousal conditions that were taken before the specific crime instructions, after the crime instructions, after the commission of the crime, and 2 weeks later at the recall interview. These checks demonstrated that intended manipulations of arousal were successful. That is, many of the heart rate and blood pressure measures indicated that as arousal increased, physiological measures increased. Table 1 provides the blood pressure and heart rate data across arousal conditions.

Before crime instructions and follow-up interview

Both of these time points served as a form of baseline measurement, and therefore equivalence of arousal conditions at these time points provides evidence that any differences in blood pressure or heart rate observed during the experiment were a function of experimental condition. As anticipated, none of the diastolic or systolic blood pressures or heart rate measurements differed across arousal conditions, all Fs ≤ 1.73.

After crime instructions

Neither diastolic nor systolic blood pressures differed across arousal conditions, all Fs ≤ 1.32. However, heart rate differed significantly across arousal conditions, $F(2, 45) = 3.90$, $p = .03$, and post hoc least significant difference (LSD) probes indicated that participants in the high-arousal condition had significantly higher heart rates than participants in the low-arousal condition before the commission of the theft, $p < .01$. Participants in the moderate-arousal condition did not differ from either high-arousal, $p = .07$, or low-arousal, $p = .37$, participants.

After crime

Diastolic and systolic blood pressures differed significantly across arousal conditions, $F(2, 46) = 3.63$, $p = .01$, and $F(2, 46) = 5.15$, $p = .01$, respectively. LSD probes indicated that high-arousal participants had higher diastolic and systolic blood pressures than moderate-arousal participants, $p = .01$ and $p < .01$, respectively, and higher systolic blood pressures than low-arousal participants, $p = .03$. No other comparisons were significantly different, ps $> .07$. Heart rate differences were in the anticipated direction but were marginally significant, $F(2, 46) = 2.95$, $p = .06$.

Recall accuracy

TOTAL MAP SCORES.

Map responses were analyzed within a 3 (arousal: low, moderate, high) × 2 (proximity: proximal, distal) × 2 (gender: male, female) mixed model analy-

sis of variance (ANOVA). Consistent with anticipated effects, there was a main effect of proximity, $F(1, 41) = 50.51$, $p < .01$, $\eta^2 = .55$; participants recorded more correct proximal ($M = 7.98$, $SD = 3.10$) than distal ($M = 4.57$, $SD = 2.16$) information on the map. Consistent with our expectations, there was a main effect of arousal, $F(2, 41) = 3.43$, $p = .05$, $\eta^2 = .14$; overall, participants in the moderate ($M = 13.38$, $SD = 4.66$) and high ($M = 13.87$, $SD = 3.00$) arousal conditions reported more correct information on the map than participants in the low-arousal condition ($M = 10.50$, $SD = 4.43$), ps = .05 and .02, respectively. See Table 2 for descriptive information about these effects. Finally, there was a main effect of gender, $F(1, 41) = 4.29$, $p = .05$, $\eta^2 = .10$; men obtained higher scores on the map ($M = 13.77$, $SD = 4.36$) than did women ($M = 11.48$, $SD = 4.02$). However, there was no interaction between arousal and proximity, $p = .49$.

OBJECT RECALL.

The numbers of correct proximal objects reported by participants in the interview were counted and entered into a 3 (arousal) × 2 (gender) ANOVA. Although women recalled slightly more objects than men in all arousal conditions, there were neither main effects nor interactions involving gender, Fs < .76, ps ≥ .08. No other effects were significant.

Remembrances: Interview narratives

WORD COUNTS.

First, the number of words spoken was entered into a 3 (arousal) × 2 (proximity) × 2 (gender) ANOVA. Consistent with anticipated effects, there was a main effect of proximity, $F(1,37) = 95.27$, $p < .01$, $\eta^2 = .72$; participants provided more words about proximal ($M = 710.16$, $SD = 303.85$) than distal ($M = 210.07$, $SD = 202.86$) components. There was no main effect of gender, $F(1, 37) = 0.56$, or arousal, $F(2, 37) = 0.21$, and no interactions were significant, Fs < 2.74, ps ≥ .08.

TABLE 2. Mean (*SD*) total map scores

	Arousal		
	Low	Moderate	High
Proximal	6.69 (3.42)	8.63 (3.14)	8.67 (2.35)
Distal	3.81 (1.72)	4.75 (2.79)	5.20 (1.66)

Next, the percentage of words (as a function of total words spoken) assigned to the cognition, location, emotion, object, and person categories were entered into separate 3 (arousal) × 2 (proximity) × 2 (gender) ANOVAs. Table 3 includes the mean percentage of cognition, location, emotion, object, person, and temporal words as a function of arousal, proximity, and gender. Because of the small number of participants in each cell of the three-way interactions (as few as three), we explored only two-way interactions that were subsumed under significant three-way interactions (this occurred for only two of nine dependent variables).

COGNITION.

There was a main effect of arousal, $F(2, 37) = 3.13$, $p = .05$, $\eta^2 = .15$, that was qualified by a significant proximity × arousal interaction, $F(2, 37) = 3.33$, $p = .05$, $\eta^2 = .15$. We examined the effect of arousal for reporting of proximal and distal information separately. For proximal information, there was an effect of arousal, $F(2, 42) = 5.99$, $p < .01$, $\eta^2 = .23$; post hoc LSD tests indicated that participants in the low-arousal condition ($M = 0.91$, $SD = 0.79$) reported a higher percentage of cognition words than participants in the moderate-arousal ($M = 0.45$, $SD = 0.41$) and high-arousal ($M = 0.22$, $SD = 0.15$) conditions, $p < .01$. Participants in the moderate-arousal condition did not differ from high-arousal participants, $p = .26$. For cognition words regarding the distal environment, there was no difference as a function of arousal level, $F(2, 42) = 0.61$, $p = .55$, $\eta^2 = .03$. Figure 1 illustrates this interaction. There was also a three-way interaction between proximity, gender, and arousal, $F(2, 37) = 8.12$, $p < .01$, $\eta^2 = .31$ that we did not probe for the reasons described earlier.

LOCATION.

There was a main effect of proximity, $F(1, 37) = 112.09$, $p < .01$, $\eta^2 = .75$, that was qualified by an interaction between proximity and arousal, $F(2, 37) = 3.84$, $p = .03$, $\eta^2 = .17$, and an interaction between gender and arousal, $F(2, 37) = 3.41$, $p = .04$, $\eta^2 = .16$. To explore the proximity × arousal interaction, we examined the effect of arousal for each of proximal and distal details. For proximal details, there was no ef-

TABLE 3. Mean (*SD*) percentage of interview details

	Cognition	Location	Emotion	Object	Person	Temporal
Overall	0.48 (0.40)	0.85 (0.47)	0.44 (0.39)	5.45 (1.56)	2.13 (1.34)	0.16 (0.21)
Proximity						
Proximal	0.55 (0.60)	0.38 (0.38)	0.45 (0.39)	6.69 (2.94)	2.28 (1.96)	0.17 (0.24)
Distal	0.50 (0.63)	3.08 (1.71)	0.40 (0.76)	2.70 (1.61)	2.47 (2.34)	0.17 (0.39)
Arousal						
Low	0.67 (0.47)	0.79 (0.47)	0.29 (0.23)	5.73 (1.50)	2.24 (1.35)	0.19 (0.22)
Moderate	0.48 (0.38)	0.84 (0.50)	0.54 (0.50)	5.19 (1.70)	2.02 (1.46)	0.19 (0.25)
High	0.23 (0.14)	0.92 (0.45)	0.48 (0.34)	5.44 (1.50)	2.14 (1.27)	0.09 (0.12)
Gender						
Male	0.46 (0.39)	0.91 (0.47)	0.45 (0.38)	5.17 (1.48)	2.29 (1.68)	0.21 (0.25)
Female	0.50 (0.42)	0.79 (0.47)	0.42 (0.40)	5.69 (1.62)	1.99 (0.99)	0.12 (0.16)

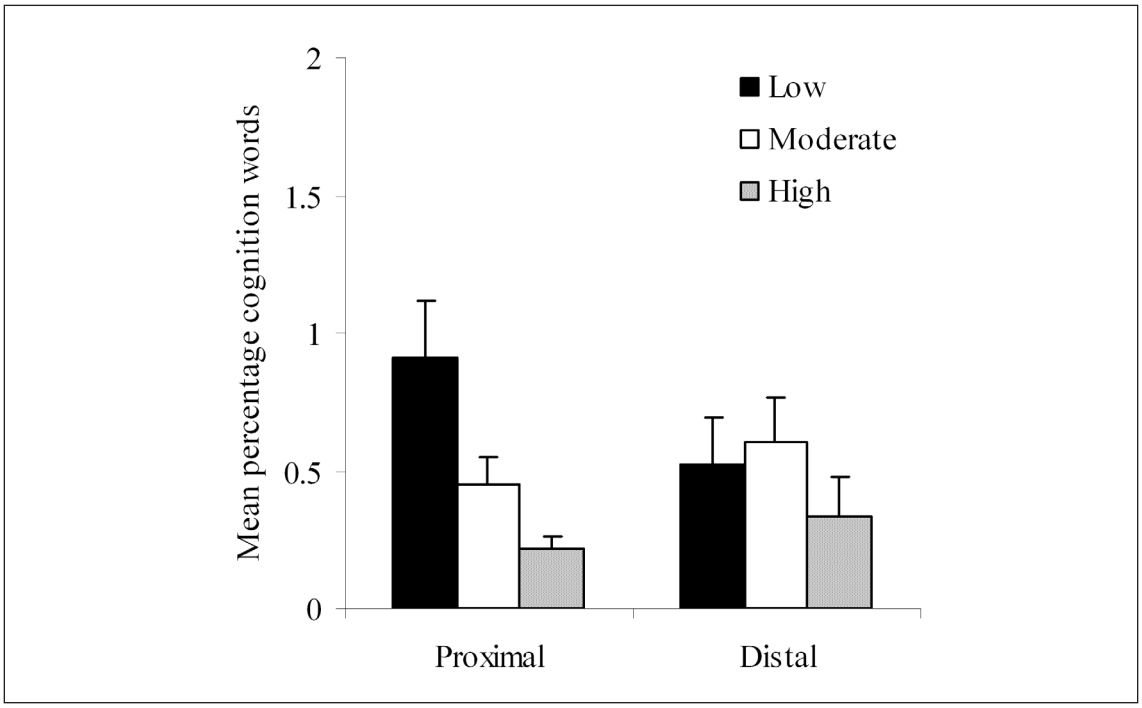

FIGURE 1. Mean percentage of cognition words (with standard errors) as a function of proximity and arousal

fect of arousal, $F(2, 42) = 1.36$, $p = .27$, $\eta^2 = .06$. For distal details, there was a marginal effect of arousal, $F(2, 42) = 2.94$, $p = .06$, $\eta^2 = .13$. Participants in the high-arousal condition reported a higher percentage of distal details ($M = 3.82$, $SD = 1.39$) than participants in the low-arousal condition ($M = 2.32$, $SD = 1.48$), $p = .02$. Participants in the moderate-arousal condition did not differ from those in the other two conditions ($M = 3.22$, $SD = 1.91$), ps > .12. Figure 2 illustrates this interaction. To explore the gender × arousal interaction, we examined the effect of gender at each level of arousal. For the low- and moderate-arousal

conditions, there were no significant gender differences, Fs < .86. In the high-arousal condition, however, men reported a higher percentage of location words (M = 1.28, SD = 0.25) than women (M = 0.74, SD = 0.43), $F(1, 11) = 5.11$, $p < .05$, $\eta^2 = .34$. There was also a significant three-way interaction, $F(2, 37) = 3.41$, $p < .05$, $\eta^2 = .16$, that was not explored further for reasons described earlier.

EMOTION.

There was a proximity × gender interaction, $F(1, 37) = 6.09$, $p = .02$, $\eta^2 = .14$. To explore this interaction, we examined the effect of proximity for each gender. For men, there was no difference in reports of proximal (M = 0.40, SD = 0.35) and distal (M = 0.62, SD = 0.95) words, $t(19) = 1.08$, $p = .30$. For women there was a significant difference, with a higher percentage of proximal (M = 0.50, SD = 0.43) than distal (M = 0.20, SD = 0.48) emotion words reported, $t(22) = 3.23$, $p < .01$.

OBJECT.

There was a main effect of gender, $F(1, 37) = 4.30$, $p < .05$, $\eta^2 = .10$; women (M = 5.69, SD = 1.62) reported a higher percentage of object words than men (M = 5.17, SD = 1.48). There was also a main effect of proximity, $F(1, 37) = 60.82$, $p < .01$, $\eta^2 = .62$; participants reported a higher percentage of object words that were proximal (M = 6.69, SD = 2.94) than distal (M = 2.70, SD = 1.61). This main effect was qualified by a proximity × arousal interaction, $F(2, 37) = 3.55$, $p = .04$, $\eta^2 = .16$. To explore this interaction, we examined the effect of arousal for each of distal and proximal details. For distal details, there was no difference in reports of objects words as a function of arousal, $F(2, 42) = 0.97$, $p = .39$, $\eta^2 = .05$. For proximal details, there was a marginal effect of arousal, $F(2, 42) = 2.85$, $p = .07$, $\eta^2 = .13$. Post hoc LSD tests indicated that participants in the low-arousal condition reported a higher percentage of objects words (M = 8.08, SD = 3.88) than participants in the moderate-arousal condition (M = 5.77, SD = 2.31), $p = .03$. Participants in the high-arousal condition (M = 6.18, SD = 1.60) did not differ from those in the other two conditions.

PERSON.

There were no significant effects of arousal, proximity, or gender, Fs < 0.50, ps > .63.

TEMPORAL.

There were no significant effects of arousal, proximity, or gender, Fs < 0.80, ps > .40.

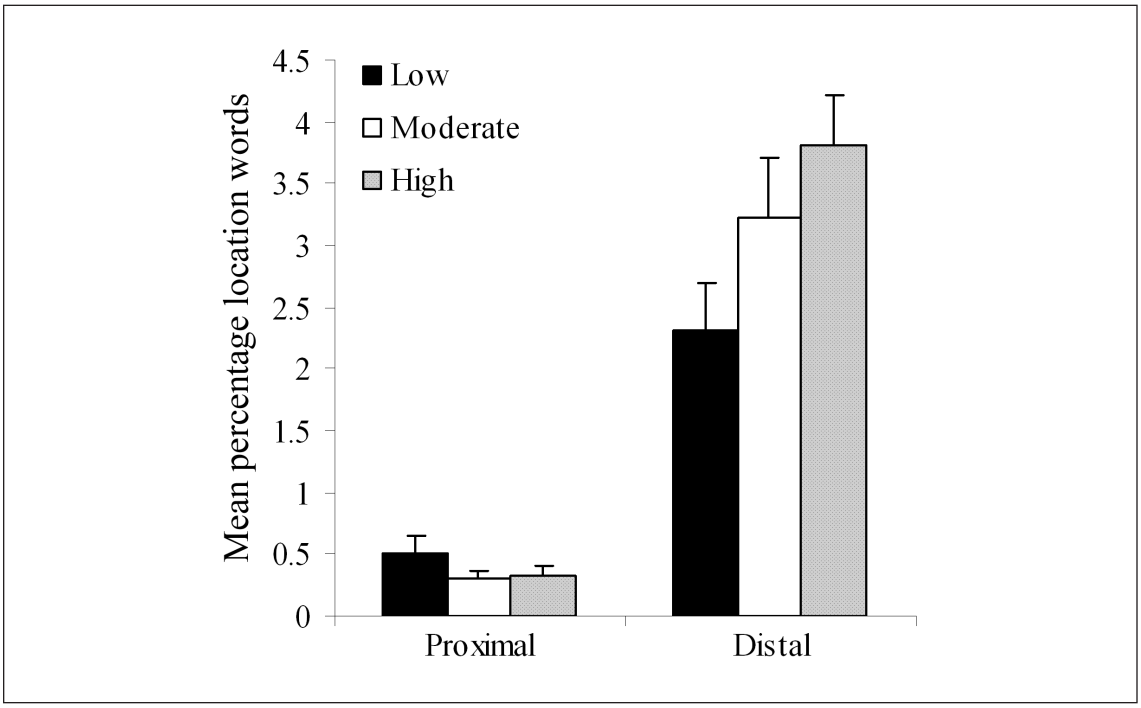

FIGURE 2. Mean percentage of location words (with standard errors) as a function of proximity and arousal

DISCUSSION

Much of the literature on eyewitness memory has focused on the recall of witnesses or bystanders of passively observed events. Little attention has been paid to the memory of active participants such as perpetrators. The present study used the mock crime paradigm of Read et al. (1992; Yuille & Tollestrup, 1990) to examine male and female participants' memory for the commission of a crime. The findings evinced a clear advantage of proximity on accuracy and metacognitive remembrances, infrequent effects of arousal and interactions between proximity and arousal, and support for an advantage for men over women on recall tasks involving spatial information.

Proximity

Consistent with our expectations, for the map scores and the word count measures there was a clear advantage of recall of proximal over distal information. The generally large main effects of proximity on recall are not surprising because given the task instructions and the expected relationship between centrality and proximity, superior recall of the crime (i.e., proximal information) was anticipated. For the metacognitive remembrances, reports of proximal and distal information were equally clear: With the exception of location information (for which distal information is particularly relevant), categories of remembrances evinced a greater frequency of verbal references to proximal than distal information (although some of these effects were qualified by interactions).

The findings regarding the main effect of proximity are largely consistent with what one would expect from a central–peripheral manipulation. Although it is only the result of a preliminary investigation, this finding warrants further exploration because of the potential implications for understanding witness testimony, particularly with regard to incidents involving multiple witnesses. A carefully controlled lab manipulation with stimuli comparable to that used in previous research finding superiority of recall of central over peripheral details would be an excellent start. Furthermore, a controlled experiment in which exposure times to distal and proximal components of the task are equated would be helpful. Although exposure time to the two components was not equated in the present study, given the complexity of the route to and from the crime room we believe exposure times for proximal and distal details did not differ substantially. Nonetheless, the measurement and comparison of variable exposure times would be prudent. Had exposure time to distal information been longer, the predicted effects of proximal recall advantage would have been diminished. Given that many significant proximal effects were observed, this possibility is unlikely in the present study. Conversely, had exposure time for the proximal details been longer, we would anticipate a greater focus on, and perhaps more extensive encoding of, proximal details. This probably would have resulted in a greater proportion of metacognitive remembrances focused on proximal rather than distal information. Although we do not have these data, it is our strong impression that the differences were not substantial.[4] Finally, an experimental design that allows the comparison of the meaning or relevance of details (i.e., the way in which centrality has typically been defined), relative to the proximity of details (i.e., the way in which centrality was defined in the present study), is an important next step.

Arousal

Although previous research has demonstrated enhanced memory for certain types of information when arousal is increased (Christianson & Loftus, 1991; Read et al., 1992, Experiment 2), our overall findings were inconsistent regarding the impact of arousal on recall. On one hand, and in agreement with previous work (e.g., Bahrick, Parker, Fivush, & Levitt, 1998), reports of some information (route and location) increased with increased arousal: Map scores and remembrances of some types of distal information (location) were higher for the moderate-arousal (map) and high-arousal (map and location) conditions than the low-arousal condition. On the other hand, there was also some evidence that arousal led to diminished reports of specific types of information. In particular, as arousal increased, recollection of proximal cognition and object information decreased. It is reasonable to speculate that as the task demands increased with increased arousal, participants assigned more attentional resources to completing the task or, at a minimum, encoding of their thoughts about suc-

cessfully completing the task decreased. Finally, there was also evidence in some recall indices that arousal was simply unrelated to recall (i.e., narrative word count, object recall, emotion, person, and temporal remembrances). The inconsistencies observed in the proximity–arousal relationship echo those found in other studies that have sought to explore a similar centrality–arousal relationship (e.g., Christianson & Hübinette, 1993).

These findings suggest that the impact of arousal may vary as a function of the type of information remembered. Therefore, the relationship between arousal and recall may be more complex than currently understood. However, it may also be the case that these inconsistent patterns of recall are due to the specific dependent measures examined, because we are not aware of any studies of perpetrator memory that have examined the impact of arousal on metacognitive remembrances of such types of details.

Proximity and arousal

It is interesting that none of the measures in the present study showed an increase in reports of proximal relative to distal information at higher levels of arousal. One explanation for the lack of observing such an interaction may derive from the fact that few details were recalled in general. Overall, there were very few cognition and emotion details (i.e., less than 1%). Therefore, there may have been insufficient power to detect differences. In the future, it may be interesting to use an interview protocol that specifically inquires about cognitions and emotions to further explore potential differences. Furthermore, as noted earlier, this finding may be due to the specific dependent measures examined. Therefore, it would also be interesting to examine whether similar results are obtained when other types of details are coded. In contrast, for location information, the number of verbal references to the distal component increased as arousal increased. Thus, as the pressure to complete the task increased, the relative importance of distal information appears to have increased. However, these findings may not be surprising given the nature and relevance of location information to completion of the task. Recall that location comments were ones that referred to specific places or locations. Because there were simply more locations to encounter along the route to the crime (which would be considered distal information) than within the crime room (proximal information), it is certainly reasonable that such a difference might exist. Alternatively, given the greater relevance of distal than proximal location information to the crime itself, an argument could be made that these findings mimic those of centrality. In other words, a perpetrator's route to and away from the crime may be more relevant to the execution of the crime than the locations of objects and actions in the crime room and therefore might be considered central in the standard use of the term in prior research.

If one assumed that proximity would operate similarly to centrality in its relation to arousal, then one would expect an interaction between proximity and arousal. However, it is clear that proximity may operate differently than centrality in regard to arousal. We hesitate to draw a broad conclusion with the present research because of the limited number of participants. For one index of recall (e.g., location details), there was evidence that the relationship between proximity and arousal may indeed overlap with centrality, but further work is needed. Alternatively, perhaps proximity and centrality together make up a kind of "thematic centrality" (Laney et al., 2003). In other words, details that are both proximal and meaningful to the task may be those that are best recalled and demonstrate findings consistent with the narrowing of attention with increasing arousal.

Gender

Despite limited previous research indicating that women may be superior to men in their eyewitness accounts (Lindholm & Christianson, 1998), our findings indicated that, where differences existed, men were generally superior on the spatial tasks used in the present study. Men recalled more information on the map construction task, although this is not unexpected given the large literature indicating that men are generally more skilled at spatial tasks (e.g., Halpern & LaMay, 2000; Voyer, Voyer, & Bryden, 1995; Weiss, Kemmler, Deisenhammer, Fleischhacker, & Delazer, 2003), and the map task itself was largely spatial. Men also more frequently referenced location information in their narratives overall, and specifically in the high-arousal condition, which again may be a result of men being more

focused on spatial tasks, and when they are highly aroused, this gender difference may be magnified. The only other gender main effect was found in relation to remembrances of objects, which women were more likely to report. This, too, is consistent with gender stereotypes, with women focusing more on objects (which may have some overlap with landmarks).

Limitations

One could argue that the level of arousal present in real-world crimes was not achieved in the present study. However, we did obtain significant differences in physiological measures between levels of arousal and are comfortable concluding that our levels of arousal influenced participants' arousal to a point that may be encountered in some forensic settings. A second potential limitation is that participants were informed that there would be a memory test, whereas real witnesses are not likewise prepared. Although witnesses to crimes may be aware that they will be questioned by police, future studies may wish to examine whether recall is affected when participants are not specifically informed about a subsequent memory test. Finally, challenges in recruiting and retaining participants led to a lower number of participants than was desirable, so less power than anticipated characterized the present study.

In conclusion, we found that arousal improved recall of a target event on a map accuracy test but had little impact on remembrances. We also found that recall of information that was spatially and temporally proximal to an event was superior to information derived from more distal experiences, which provides some support for the spatial–temporal distinction as a useful proxy for the central–peripheral distinction. Although we did not find support for interactions between proximity and arousal, the differences observed may be a function of the types of details examined and the use of a long delay to recall. The unique paradigm used in this study offered the opportunity to study a "criminal's" memory for a complex, arousing event in a way that has not often been examined experimentally. In the future, an examination of the overlap between definitions of centrality and proximity with more traditional stimuli may prove informative.

NOTES

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1. Although this distinction was initially conceptualized as an independent variable, there were no interactions between role and arousal, and so all reported analyses are collapsed across role. We originally anticipated that differences in level of involvement in the activity between perpetrators and accomplices may be a moderating variable for eyewitness memory (Yuille et al., 1994) and that we may see overall differences in performance between perpetrators and witnesses to the same event. However, despite our hopes and instructions to the contrary, the manipulation resulted in no difference in level of involvement between perpetrators and accomplices, probably because both perceived themselves to be "co-perpetrators" given that "accomplices" were actively engaged in the task insofar as they navigated their way to and from the crime room together and were together in the office while the exam was "stolen."

2. Standard instructions for the Cognitive Interview include asking the reporter to recall the event from different perspectives in order to obtain a comprehensive narrative. Analyses were not conducted to examine the influence of perspective shift because all participants were instructed to recall the event from a different perspective, and there were no expectations of differences as a function of shift in recall perspective.

3. Interrater reliability guidelines are as follows: .40 and under is poor, .40 to .59 is fair, .60 to .74 is good, and .75 and above is excellent.

4. This impression is based on the short period of time in which all participants completed the task and the knowledge of the minimum amount of time needed to complete the "theft."

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