End Violence Against Women International
(EVAWI)

Important Things to Get Right About the "Neurobiology of Trauma"

Part 3: Memory Processes

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This training bulletin series explores some central concepts in the "neurobiology of trauma," as it is understood by people working with sexual assault victims. Understanding essential scientific findings and avoiding any misinterpretation or misapplication can help professionals work more effectively with survivors. In this final installment in the series, I focus on key issues involved in memory retrieval or recall.

Memory Encoding, Storage, and Retrieval

During any experience, we are paying more attention to some aspects of it than others. And of those aspects that get our attention, some have more emotional significance attached to them than others. The parts of an experience that are encoded into short-term memory (and stored for about 30-seconds), and then prioritized for storage in long-term memory (potentially the rest of one's life), are selected for encoding and storage as a function of both *attention* and *significance.*[1] In memory science, the parts of an experience that get substantial attention and significance are called **central details**, while the parts that get little attention or significance are **peripheral details**.[2] Some things that are happening during an event aren't even noticed by the brain and never get encoded into memory.

The neurobiological impacts of stress and trauma can increase the "storage strength" of central details.[3] Furthermore, when the brain's defense circuitry takes over and impairs the prefrontal cortex,[4] that can also result in the "tunnel vision" that police officers understand from critical incidents and soldiers know from combat experiences.[5] Tunnel vision (and other ways attention can be narrowed) result in a heightened focus on *some* parts of an experience but not others, which causes some details to never be encoded into memory and others to be lost from memory because they were experienced as peripheral in those moments.

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[1] Cohen, N., Pell, L., Edelson, M.G., Ben-Yakov, A., Pine, A. & Dudai, Y. (2014). Peri-encoding predictors of memory encoding and consolidation. *Neuroscience & Biobehavioral Reviews, 50,* 128-142; Levine, L.J. & Edelstein, R.S. (2009). Emotion and memory narrowing: A review and goal-relevance approach. *Cognition and Emotion, 23,* 833-875.

[2] Levine, L.J. & Edelstein R.S. (2009). Emotion and memory narrowing: A review and goal-relevance approach. *Cognition and Emotion*, 23, 833-875. For additional information, see Hopper, J. (2018). Why incomplete sexual assault memories can be very reliable. Sexual Assault and the Brain (blog), *Psychology Today;* Hopper, J. (2016). *Neurobiology of Sexual Assault (Part 2: Experience and Memory).* EVAWI webinar series; Wilson C., Lonsway, K.A. & Archambault, J. (2016). *Understanding the Neurobiology of Trauma and Implications for Interviewing Victims.* EVAWI training bulletin.

[3] McGaugh, J.L. (2015). Consolidating memories. *Annual Review of Psychology, 66,* 1-24.

[4] Kozlowska, K., et al. (2015). Fear and the defense cascade: Clinical implications and management. *Harvard Review of Psychiatry, 23,* 263-287; Arnsten, A.F.T. (2009). Stress signalling pathways that impair prefrontal cortex structure and function. *Nature Reviews Neuroscience, 10,* 410-422; Arnsten, A.F.T. (2015). Stress weakens prefrontal networks: molecular insults to higher cognition. *Nature Neuroscience, 18,* 1376-1385.

[5] Mather, M. & Sutherland, M. R. (2011). Arousal-biased competition in perception and memory. *Perspectives in Psychological Science, 6,* 114-133; Clewett, D.V., Huano, R., Velesco, R. & Mather, M. (2018). Locus coeruleus activity strengthens prioritized memories under arousal. *Journal of Neuroscience, 38,* 1558-1574.

Most peripheral details will fade from memory within 24 hours, unless they happen to be recalled and then re-encoded and re-stored in the brain.[6] And even for central details, not all will be saved in memory forever, or even for a period of weeks, months, or years.

No One Can Remember "Everything"

If we reflect for a moment, these scientific facts fit with our lived experience and common sense. However, some people sincerely believe they "remember everything" about a stressful, traumatic, or otherwise emotionally significant experience they have had. Others believe the right interviewing methods can help people remember "everything."

It just isn't true. **No one can remember "everything" about any experience they have had, including a traumatic experience such as sexual assault.** Some people will remember more than others, but what people remember will always be a function of what their brain paid attention to and gave emotional significance to at the time. There will always be some information, including potentially important information, that simply does not get encoded or stored in memory.[7] Understanding this can help investigators and others avoid unrealistic expectations about what sexual assault victims will remember, including that they can remember "everything."

Recall Can Get Better Over Time

As noted above, peripheral details that are stored in memory about an event fade fast, and even some central details can be lost over time. But what people can recall – by retrieving into awareness (some of) what is still stored in the brain – *can improve over time.* That's because **retrieval conditions** can improve. For example, a second interview with law enforcement may be conducted, in comparison to the first interview, in a way that makes it easier for a person to remember details. In that sense people's memories (in terms of what can be retrieved, not what is stored) can and often do get better over time.

An important factor in memory retrieval is the victim's **stress level.** Because stress impairs retrieval,[8] a decrease in stress can increase a person's recall. For example, the

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[6] Antony, J.W., Ferreira, C.S., Norman, K.A. & Wimber, M. (2017). Retrieval as a fast route to memory consolidation. *Trends in Cognitive Sciences, 21,* 573-576.

[7] In addition to the central/peripheral phenomenon, there are time-dependent neurobiological impacts of stress and trauma on the functioning of the memory circuitry, such that there tends to be an initial "super-encoding phase" that's followed (from 5 to 20 minutes later) by a minimal encoding phase. During each of those phases the central/peripheral distinction and its impacts on memory formation still apply, but both central and peripheral details are better encoded and stored during the initial than the later phase. See Hopper, J. (2018) "Why incomplete sexual assault memories can be very reliable," and "Why Christine Blasey Ford can't remember how she got home," on my blog with *Psychology Today*.

[8] Gagnon, S. A., & Wagner, A. D. (2016). Acute stress and episodic memory retrieval: neurobiological mechanisms and behavioral consequences. *Annals of the New York Academy of Sciences, 1369,* 55-75.

safer and more comfortable a victim feels with an interviewer, the less stressed they will be, and the more likely they will be able to retrieve information that is stored in memory.

Context also makes a big difference. This can include the physical space or social situation a person is in, as well as the state of their mind and body. Various strategies have been used to try to "reinstate the context" associated with a particular experience, such as visualizing or physically returning to the location of the assault. While physically revisiting the crime scene may not be possible or practical in some situations, and it can potentially be retraumatizing for victims, under some circumstances this could be effective in improving recall.[9]

Retrieval Cues

Another major factor that determines the completeness of recall is what memory researchers refer to as *retrieval cues*. This can include interview questions or prompts, which can make a huge difference in the amount and quality of information victims can recall. Effective interviewing employs questions and prompts that are open-ended, non-leading, and that elicit thoughts, feelings, and sensations – including ones the investigator would never have expected and the victim hadn't previously remembered. To illustrate, an investigator might prompt victims with: "You said he grabbed your neck, tell me more about that," or "What were you thinking or feeling when he had his hands around your neck?" Such cues have the potential to trigger the activation of additional pieces of memory associated with those sensations and thoughts.

From one day to the next, from one interview to the next, or from an investigative interview to courtroom testimony months or years later, **there's always the potential for victims to recall more details, as a result of different contexts and cues.**

Helping Victims "Remember"

In short, memories *can* get better over time. And when they do, there's no scientific basis for assuming that the person's later (and more complete) memories are less reliable or credible than their earlier (and less complete) memories – even if perpetrators and their defense attorneys might argue otherwise. If we understand the basic and well-established principles of memory encoding, storage, and retrieval, then **we can strive to optimize our interviewing and investigative techniques to maximize the benefits of context- and cue-based facilitation of recall, and we can counter unwarranted attacks on victims' recollections and credibility.**

[9] For a remarkable account of investigators helping a sexual assault victim retrieve detailed memories of an experience she had been almost completely unable to recall, and thought might just be a dream, listen to Carmon, I. & Natt, O. (2019, October 15). Your driver is here / The only memory I had was getting in the car. *The Cut on Tuesdays* podcast. The section on the "reenactment ride" starts at 14:08.

Stress, Sleep, and Memory Retrieval

As one method of helping victims remember, **many professionals have been taught that law enforcement should allow sexual assault victims two full "sleep cycles"[10] before conducting an in-depth interview.** This recommendation appears to have come from the work of law enforcement trainers, including Lieutenant Colonel David Grossman and Bruce K. Siddle, who founded Pressure Point Control Tactics (PPCT).[11] It was reportedly based on studies of soldiers in combat and applied to interviews of police officers following critical incidents such as officer-involved shootings. However, no scientific evidence or neurobiological basis were provided for this recommendation, just the statement that two sleep cycles were necessary for a person who has experienced trauma to "fully recall" what happened.[12]

Putting it in Context

It is important to place this recommendation in the context of law enforcement culture and professional lore, which traditionally viewed interviews as a race against time. The assumption was that people are best able to recall an event right afterward, so every passing minute could result in a loss of critical information. The recommendation to wait two sleep cycles before interviewing officers after a critical incident was therefore a radical departure from tradition – and one designed to slow investigators down and avoid rushing the process. **Investigators were advised to conduct a preliminary interview to establish key fundamental information, then allow the officer time to rest, recover, and address logistical and emotional issues before undergoing a detailed follow-up interview.** Eventually the same logic was applied to everyone involved in a traumatic or highly stressful events, not just police officers or soldiers.

Fast-forward to today, and we can combine this practice-based recommendation with the science of stress and trauma, their impact on memory, and the role of sleep. There are three key findings to consider: (1) Sleep helps preserve some details in memory, but not others; (2) Stress impairs retrieval of memories; and (3) Sleep can reduce stress.

[10] The term "sleep cycle" has a different meaning to scientists than law enforcement. For law enforcement, it is used to describe extended periods of sleeping after a traumatic event (e.g., a night of sleep). In sleep research, however, "sleep cycle" refers to approximately 90-minute sequences that repeat several times over the course of a night of sleep, with each cycle divided into periods of rapid eye-movement (REM) sleep and non-REM (NREM) sleep. NREM is further divided into four stages.

[11] PPCT Management Systems, Inc. (1989), *Use of Force Human Factor* (Chapter 1).

[12] As explained above, no one ever has "full recall" of any experience, because it is always the case that some details are not noticed or encoded into memory during the event; that some of the details that are encoded and stored (peripheral details) rapidly fade from memory storage (in the absence of retrieval, which can enable re-encoding and re-storage); and that even some central details can be lost over time.

Sleep Helps Preserve Some Details, But Not Others

Researchers have found that the retention or storage of *emotionally significant central details* in memory is promoted neurobiologically during sleep. In contrast, peripheral details are lost just as rapidly during sleep as they are when people are awake.[13] Unfortunately, the details that are peripheral to someone's brain during an assault could later, during the course of an investigation, be of central importance to law enforcement.

Stress Impairs Retrieval

Just because information is stored in someone's brain, this doesn't necessarily mean it is accessible to recall. That's because stress impairs the brain's ability to retrieve memories that have been encoded and stored.[14]

People are often very stressed after a traumatic experience, and even a well-conducted interview might not elicit recall of details that are still stored in their brain. Also, even if someone approaches an interview not feeling stressed, the interview itself – even under the best circumstances – can still be stressful at times. This means that the experience of being interviewed can sometimes impede the very recall it is designed to elicit.

Sleep Can Reduce Stress

Memory retrieval impairments associated with extreme stress and trauma typically resolve when a person's stress level is reduced. This does not require sleep, but to the extent that sleep reduces stress (which it often does), it can contribute to improved memory retrieval. In other words, **it isn't about sleep per se, but rather stress reduction more generally.**

By the same principle, when victims' stress levels are reduced through compassionate care, their memory retrieval capacities could return to normal levels, sometimes even within an hour or so after the assault.

On the other hand, a victim could have two very restful nights of sleep, but then encounter trauma-related triggers that sharply increase their stress level (such as an investigator who uses interrogation tactics). This could potentially cause the victim to suffer recall impairment greater than immediately after the assault itself.

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[13] Payne, J.D., Chambers, A.M. & Kensinger, E.A. (2012), Sleep promotes lasting changes in selective memory for emotional scenes. *Frontiers in Integrative Neuroscience, 6,* 1-11; Bennion, K.A. et al. (2015). Sleep and cortisol interact to support memory consolidation. *Cerebral Cortex, 25 (3),* 646-657; Cunningham, T.J. et al. (2014). Psychophysiological arousal at encoding leads to reduced reactivity but enhanced emotional memory following sleep. *Neurobiology of Learning and Memory, 114,* 155-164.

[14] Gagnon, S.A. & Wagner, A.D. (2016). Acute stress and episodic memory retrieval: neurobiological mechanisms and behavioral consequences. *Annals of the New York Academy of Sciences, 1369,* 55-75.

For these reasons, **trauma-informed interviewing practices are always recommended, to reduce victims' stress and enhance their comfort, regardless of how much sleep they have had.**

No Magic in "Two Sleep Cycles"

In sum, there is no reason to believe that two rounds of sleep are specifically required to eliminate any stress-induced recall deficits. Because our sleeping brains are working to preserve central details in memory – but not peripheral details, which fade as quickly as if we weren't sleeping – this means waiting two sleep cycles to interview someone about their sexual assault will inevitably mean that some details will be lost during that time.

Combining Science and Practice

Too many victims are subjected to detailed interviews when they haven't eaten, have been awake for long periods of time, are intoxicated or under the influence of drugs, or are worrying about essential concerns such as children, pets, or other responsibilities for family, work or school. Victims are often exhausted, confused, and struggling just to absorb what happened. They may not be getting the support they need from friends and family, especially if they don't have a trained victim advocate helping them.

Determining the appropriate time for a follow-up interview will require balancing these considerations with the brain-based processes described above. In most cases, **it makes sense to allow victims some time before conducting the detailed interview – time to rest, reduce stress, seek support from loved ones and victim advocates, and begin processing what happened to them. But there is no universal timeframe for that, and every victim should be approached as a unique person, with unique needs, at a particularly difficult time in their life.**

To illustrate, for victims who are sexually assaulted late at night and report to law enforcement right away, the preliminary interview and medical forensic exam process will often last into the early morning hours. Yet investigators often call the victim just a few hours later, when they are assigned the case, to schedule a follow-up interview. They think of it as "the next day," but it's still "the same day" for a victim who has been awake most of the night, going through a difficult and likely exhausting process. By scheduling the follow-up interview for the following day at the earliest, the victim will have time to get an actual night's sleep and hopefully feel better for the interview.

On the other hand, some victims may not want to wait for the detailed interview. Especially for those who report their sexual assault after some period of time has passed, they may have finally worked up the courage to contact law enforcement and want to get the interview over with as soon as possible. Victim needs should remain at the center of any decision making around when to conduct the detailed interview.

Conduct Two Investigative Interviews

EVAWI's recommendation is to conduct at least two investigative interviews in most sexual assault cases, especially for survivors who report their assault within a few hours of its occurrence. The first interview is focused on addressing emergency needs and conducting a preliminary investigation. This includes inquiring about information related to the crime scene and other potentially vital information that the victim's brain might have processed as peripheral details during the assault and are thus vulnerable to rapidly fading from memory.

The second interview is much more detailed, conducted perhaps 2-3 days after the initial response, depending on the schedule and convenience of the victim and investigator. This allows time for the investigator to take critical investigative steps such as reading the preliminary report, conducting a criminal history check on the suspect, and reviewing any reports from the medical forensic examination, crime scene, etc. This time is also necessary to make arrangements regarding any accommodations the victim may need, in terms of physical disabilities, disabilities affecting cognition or communication, or interpretive services.

In other words, memory processes are not the only factors to consider for scheduling; investigative concerns are also key. A day or two of preparation allows investigators to conduct a more informed and effective follow-up interview.

Conclusion

This concludes our series of training bulletins summarizing the neurobiological basics of how people commonly respond while being sexually assaulted, and how stress and trauma can alter their memory processes. This basic understanding can yield several key benefits for professionals: It provides more realistic expectations for victim responses during a sexual assault, more perceptive listening to their account of what happened, and more effective information-gathering about their memories and responses. These are potential game-changers for the field of sexual assault response. However, this knowledge should not be used to explain or make assumptions about any *particular* survivor's responses or memories, because each individual is unique.

When it comes to understanding common victim responses, conducting effective victim interviews, and teaching other professionals on the "neurobiology of trauma," keep it simple, but scientifically sound. Focus on a few key brain circuitries and leave brain chemicals out of it. Otherwise, the risks of getting confused and getting it wrong are high, as are the risks of confusing others, giving them a false sense of understanding, and exposing yourself and others to (unfortunately justified) attacks on your credibility – and by extension, the credibility of anyone and everyone who teaches and speaks about the "neurobiology of (sexual assault) trauma." This strategy will help the field to reap valuable benefits of this scientific understanding, while avoiding possible pitfalls.